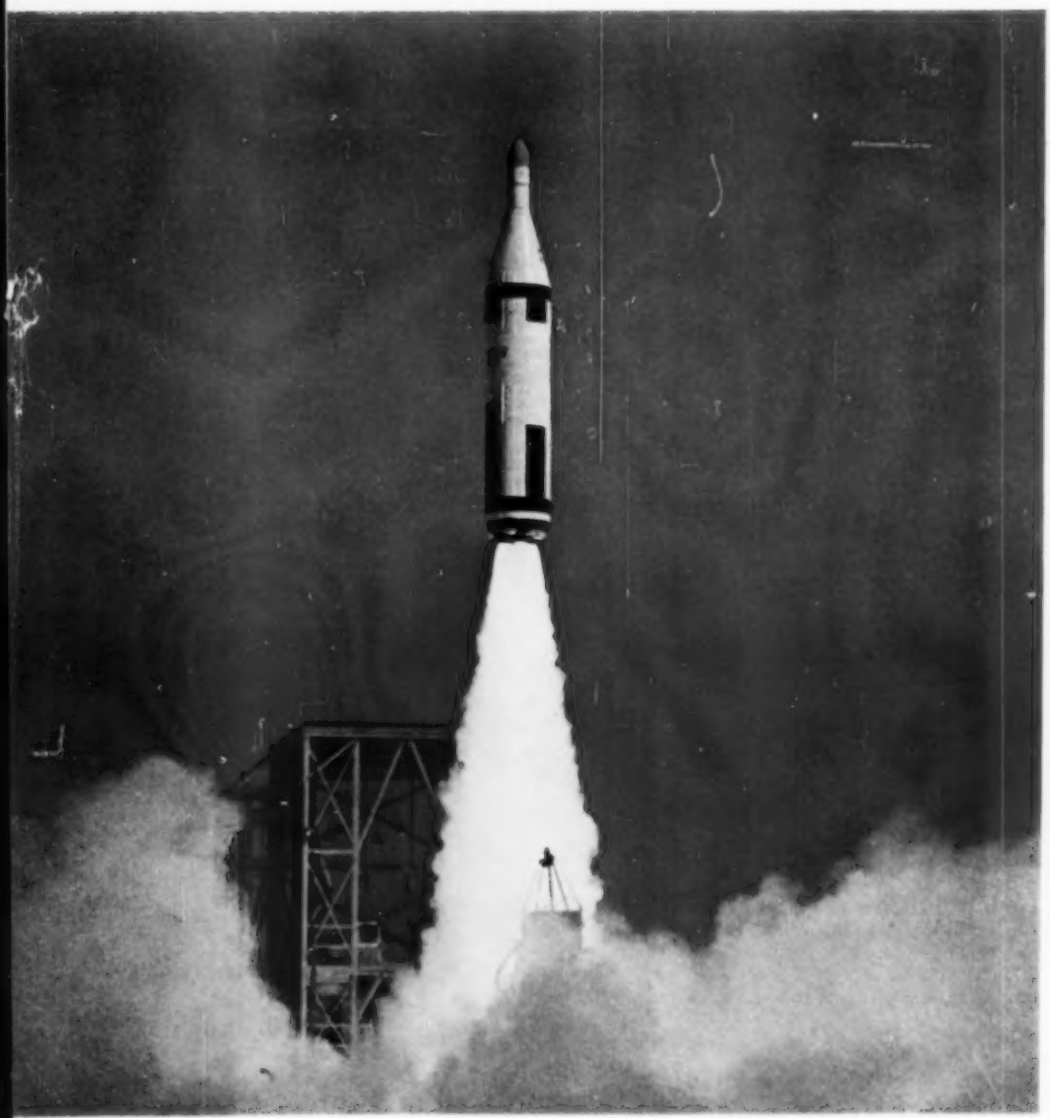
ORDNANCE

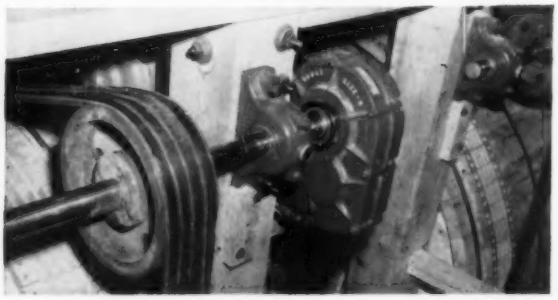
LAND • SEA • AIR • SPACE



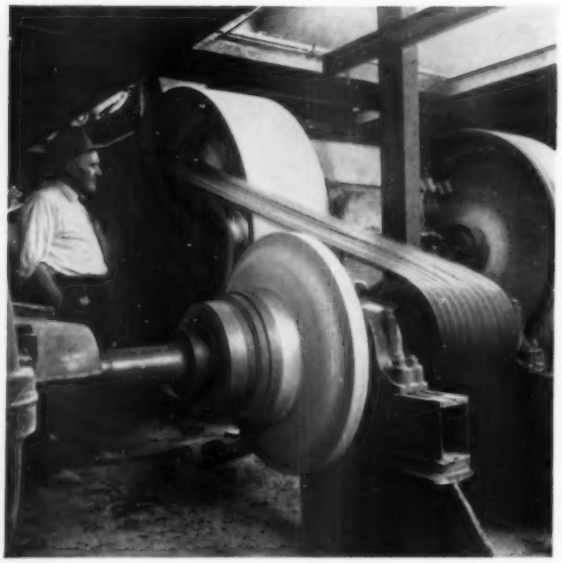
The Polaris missile

MAY-JUNE 1960

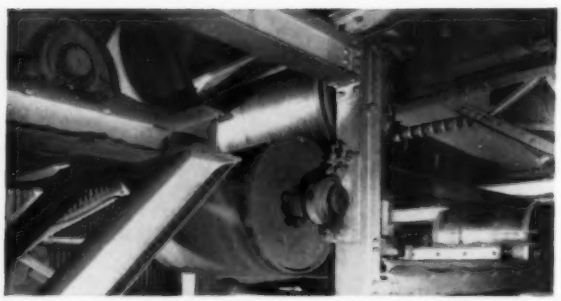
How Dodge pillow blocks with Timken® bearings give longer life with less maintenance



1. Two 2 7/16" Dodge Special Duty pillow blocks equipped with Timken® tapered roller bearings, support the line shaft driving six by eight foot tanning drums. The tapered design of Timken bearings enables them to take both radial and thrust loads in any combination.



2. The crusher at a trap rock and asphalt plant runs faster, gives more production now that Dodge Double Interlock pillow blocks on Timken bearings are installed. The Timken bearings in these blocks give full-line contact between rollers and races for greater load carrying capacity.



3. The Timken bearings in All-Steel Dodge pillow blocks must stand up under adverse operating conditions found when sintering metals. One major advantage of Timken tapered roller bearings is their ability to hold housings and shafts concentric, thus keeping lubricant in, dirt and dust out.

The photo at right shows the Dodge All-Steel pillow block Timken bearing equipped. The specially designed bearing has a tapered bore with self-aligning spherical outer surface—never needs adjustment.

There's a Dodge pillow block equipped with Timken bearings to fill every engineering need: All-Steel, Type "E", Double-Interlock, Type "C" and Special Duty. And with Timken bearings, space consuming thrust devices are not needed. Look for Timken bearings in all the machines you buy or build. They're the symbol of quality. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

BETTER-NESS rolls on

TIMKEN®

tapered roller bearings

ORDNANCE

LAND·SEA·AIR·SPACE

Forty Years of Leadership in American Armament Preparedness

VOL. XLIV | MAY-JUNE 1960 | NO. 240

The Cover.—*This Navy photograph shows the firing of a Polaris test vehicle with an instrumented nose cone from Cape Canaveral, Fla. The weapon is designed as an ICBM which can be launched from a submerged fleet ballistic missile submarine.*

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ORDNANCE is published bimonthly by the American Ordnance Association, Mills Building, Washington 6, D. C. Second-class postage paid at Washington, D. C., and at additional mailing offices.

Subscription rate: Continental United States and possessions, $5.50 annually in advance; foreign, $7.00.

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Six weeks' notice before next publication date required for change of address.

FIREPOWER, formerly published separately by the American Ordnance Association, is combined with ORDNANCE magazine.

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on the target . . . . . .

THE CONTENTS OF THIS ISSUE IN BRIEF

Freedom of Action (p. 854) . . . . Active, instead of static defense, is the only tranquilizer that will calm the jitters of the American people! Maj. George Fielding Eliot, military analyst and well-known author, tells us that Mr. and Mrs. America will be more at ease if we convince Kremlin leaders that they can never become masters of the world.

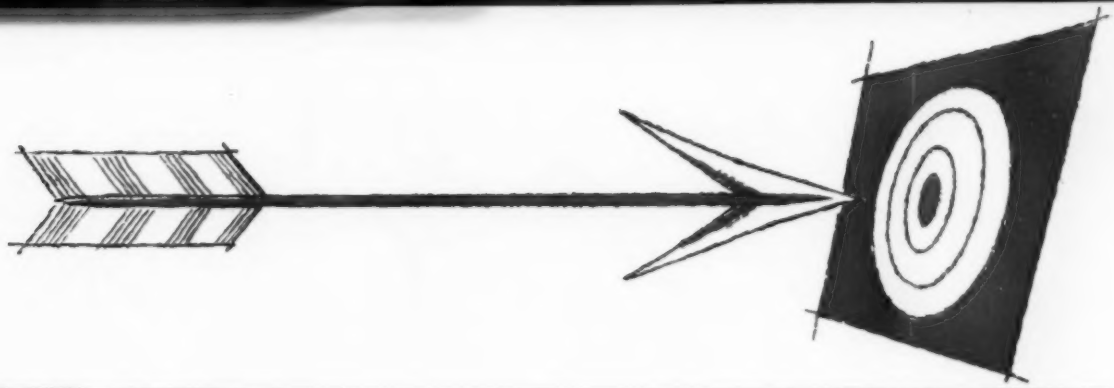
Nuclear Arms and Policy (p. 858) . . . . Let's not be fooled by a "pig in a poke" proposal for cessation of atomic tests, unless there is a clear understanding of an inspection program for all, John F. Floberg admonishes. This member of the Atomic Energy Commission feels that an understanding can be reached but that such a vital subject must not be treated as a political football.

Antisubmarine Defense (p. 862) . . . . Continents are no longer oceans apart due to advancements in aircraft patrolling the skies and in submarines which prowl the noisy jungles of the seas. Vice Adm. J. S. Thach, Commander, Antisubmarine Defense Force, Pacific Fleet, tells a dramatic story of problems confronting the Navy today, the most serious of which are detection and identification of submarines.

The Government of Space (p. 866) . . . . The age-old controversy on the limits of territorial waters has a new, but equally perplexing sister—the problem of the legal aspects of outer space. Eugene E. Wilson, noted author and leader in the aircraft industry, gives a report on the recommendations of top legal minds for controlling orbital and superorbital craft.

Will the Tank Survive? (p. 870) . . . . The "turtle" of the weapons family, the tough and remarkably sturdy tank, has been declared obsolete on many occasions, with a few experts concurring that the old war horse had outlived its usefulness. But one of England's outstanding military analysts, Capt. B. H. Liddell Hart, says the tank should live on because an armored force has a better chance of survival than infantry on the atomic battlefield.

Science in a Dynamic Air Force (p. 873) . . . . Research has come into its own in our streamlined Air Force which is placing as much emphasis on scientific discoveries as it is on engineering. Air Force Brig. Gen. B. G. Holzman, Vice Commander, Air Force Research Division, Air Research and Development Command, gives the background of ARDC and cites some of the accomplishments over the past ten years.



Battle at Brandy Station (p. 878) . . . . Heroes of this little-known Civil War engagement live again in Fairfax Downey's "Clash of Cavalry—The Battle of Brandy Station." Former Atomic Energy Commission Chairman Lewis Strauss here presents a lively review of the book which he hails as a study that conveys the "feeling of participation and excitement" of the actual conflict.

Truce of the Bear (p. 880) . . . . Are we cooperating blindly in our own destruction by our attitude of appeasement? Do we face the challenges of the Soviets squarely? Maj. Reginald Hargreaves, noted British author, thinks free-world leaders are too soft in their approach to this problem. He says that our leaders are prone to lean on sugar-coated policies rather than to carry a big stick.

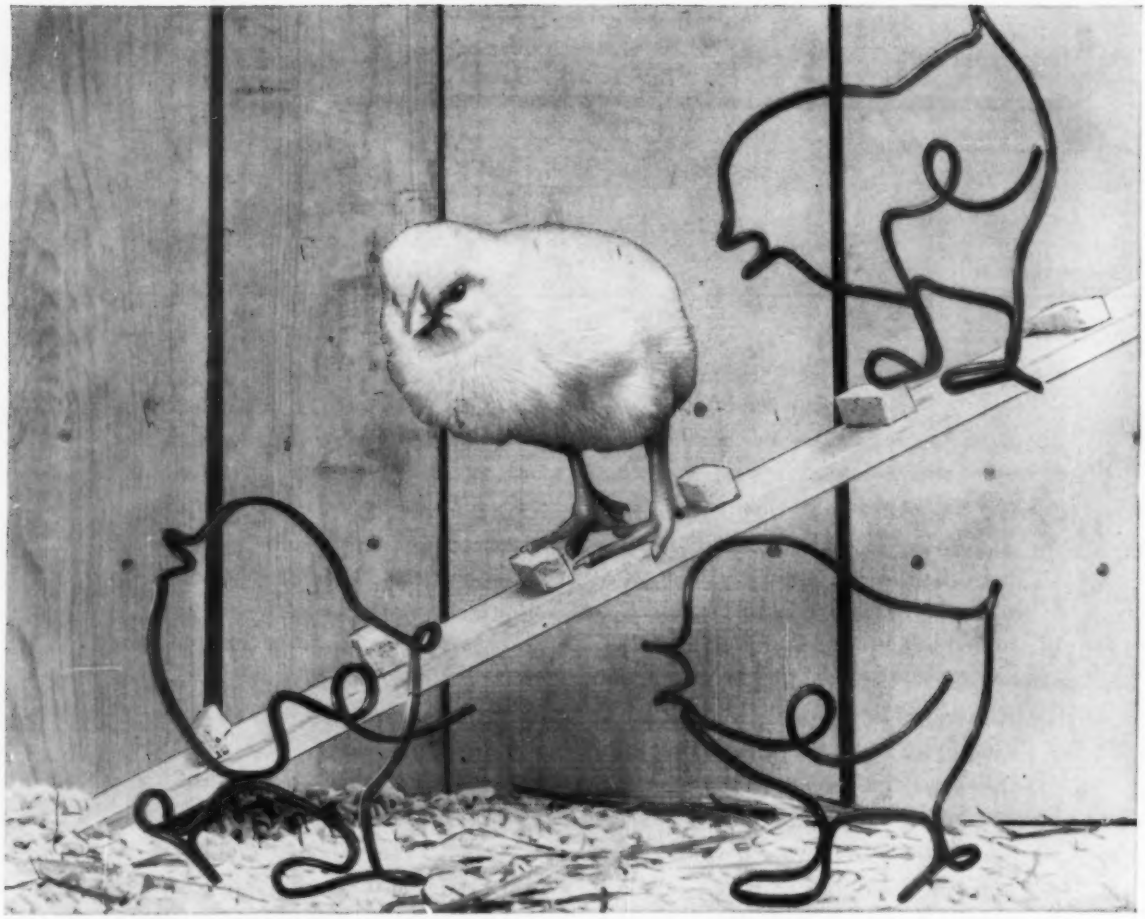
Science vs. Wisdom (p. 884) . . . . Is the United States losing the technological race? George S. Brady, ORDNANCE contributing editor, answers a young Army Ordnance captain's questions on how we fail to disseminate technical information once we have it in hand and what we can do about this failure.

Metrological Miracle (p. 945) . . . . Some of our mammoth missiles are stored in shielding silos beneath the earth's surface, and our engineers face the provocative challenge of building such structures to watchmaker's tolerances. Jeremiah F. Donovan, chief optical tooling engineer, American Machine & Foundry Company, says that these launching sites can be built now to a tolerance of one second of arc.

Weapons to Fit the Man (p. 950) . . . . Psychology applies to machines as well as men, researchers at Aberdeen Proving Ground, Md., are finding out. The human operator is a part of the weapons system—without him the weapon itself would be useless. Read this account of some of the studies that have been made in this new science, which promises to be one of the most useful in the world of tomorrow.

Powdered Metal Bullets (p. 952) . . . . You can bet your bottom bullet that Frankford Arsenal, Philadelphia, Pa., is on its toes when it comes to economizing in the making of bullets. This time, according to author Robert A. Powell of the Metallurgy Research Laboratories, Pitman-Dunn Laboratories, they have a program in full swing which will achieve economy in making the 7.62-mm. bullets of powdered metal and yet effect a saving in the critical materials of copper and lead.

Adhesives for Ordnance (p. 954) . . . . Adhesives are offering many advantages over mechanical means of attachment. As a seasoned veteran in this field, M. J. Bodnar, chief, Adhesives Research Unit, Picatinny Arsenal, N. J., gives helpful hints to ordnance designers.



Bundy can mass-fabricate practically anything

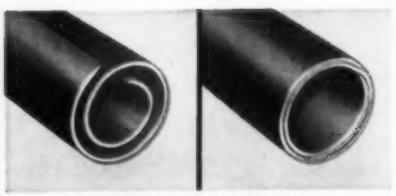
Bundyweld®—the original double-walled steel tubing—is ideal for everything from simple bends to complex shapes

The old adage, "Don't count your chickens before they hatch," is a good one . . . but it rarely applies to Bundy. That's because, no matter how complex your tubing problem, you *can* count on Bundy for the perfect solution.

Bundy engineers and designers are backed by years of experience in the mass-fabrication of steel tubing. And they are available to you at any stage of product development for time- and money-saving suggestions. Their key: Bundyweld®!

Bundyweld steel tubing is double-walled, copper-brazed, stronger, with higher bursting and fatigue strengths. That makes Bundyweld the safety standard in small-diameter tubing—and a wise choice for a wide variety of tubing applications! Covered by Government Spec. MIL-T-3520, Type III.

So, when you want to talk tubing, talk to the leader—Bundy! Phone, write, or wire Bundy Tubing Company, Detroit 14, Michigan.



Bundyweld is the original tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no substitute for the original Bundyweld Tubing.

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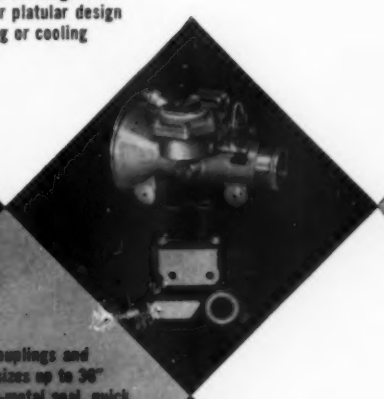
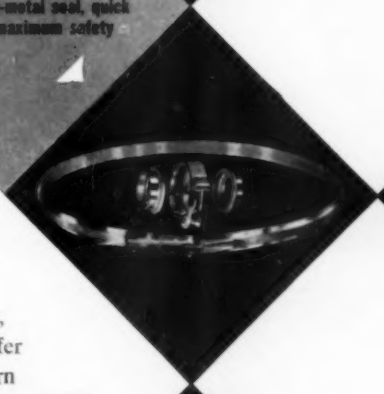
WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

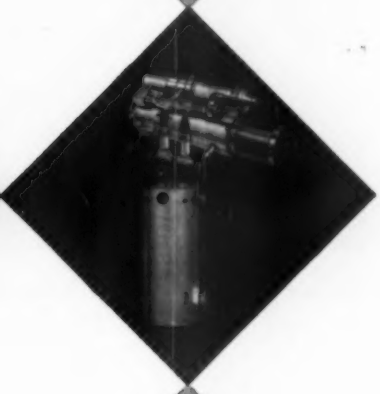
compact heat exchangers of conventional or platular design for heating or cooling



precision pneumatic controls for bleed-air combine functions saving weight and space — special control specs invited

air duct couplings and supports in sizes up to 36" feature metal-to-metal seal, quick disconnects, maximum safety





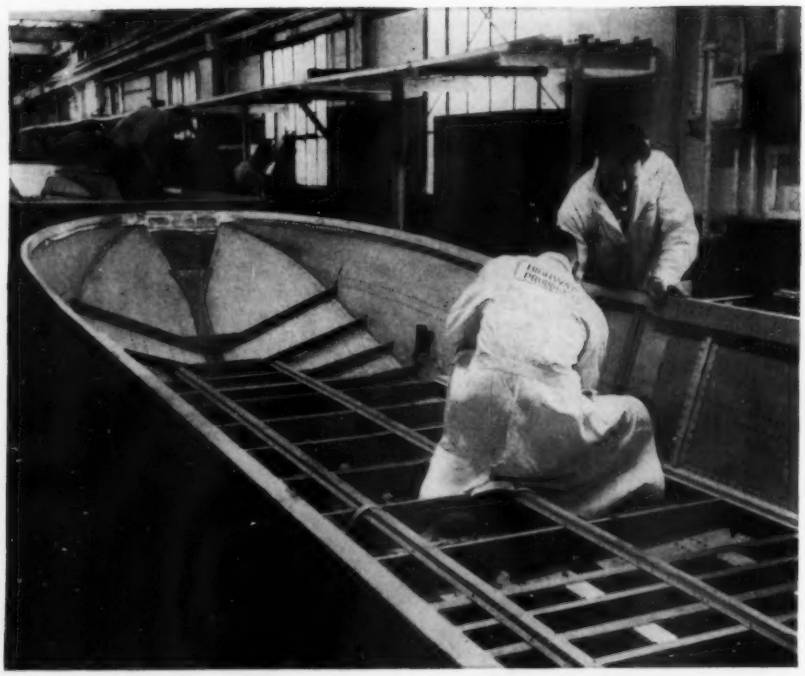
For a proposal you can rely on contact your Janitrol engineering representative when your plans call for components, pneumatic sub-systems, and complete systems for heat transfer and air control. Virtually every modern aircraft and operational missile incorporates the skills that Janitrol translates into practical hardware. Janitrol Aircraft, a division of Midland-Ross Corporation, 4200 Surface Road, Columbus 4, Ohio

liquid heaters for ground support equipment in compact sizes to 1 million Btu/hr — multi-fuel use

combustion systems include hot fuel prime units, inert gas generators and aircraft heaters

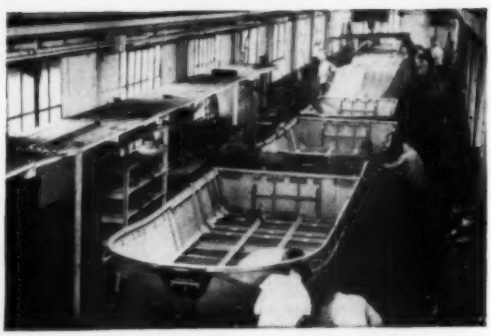
JANITROL

reliable components for missiles / aircraft / support



ALCOA supplied extrusions, castings, sheet, plate, tubing, rivets.

EACH half ponton requires over 8,000 rivets.



HALF pontons measure 18½ ft long by 11 ft wide; weigh 645 lb.

FLOATING BRIDGES FOR G.I.'s show how Alcoa helps its customers

HIGHWAY PRODUCTS COMPANY is a bus and van fabricator that is helping the Army build a portable aluminum bridge. Incongruous? Not at all. The company's 200 employees average almost 27 years' experience in metal fabrication.

THEIR ROLE in the bridge building is an Army contract for 625 aluminum pontons. When the first 80 pontons were delivered, the Army expressed its pleasure in the quality and promptness of the firm's work.

THE JOB was not without complications. First, there was the matter of material. The local Alcoa salesman was on the scene to help the company's engineers to determine alloys, grades and tempers.

THEN, there was the matter of method. Alcoa's Process Development engineers provided technical assistance when trouble developed in building a large section of the ponton. They also helped reduce the man-hours being put into the project.

FINALLY, there was the matter of supply. The order called for approximately 750,000 lb of aluminum and 10,000,000 rivets. Seven Alcoa plants went to work—Lancaster, Pa., and Vernon, Calif., supplied rivets . . . Lafayette, Ind., and Cressona, Pa., extrusions . . . Davenport, Iowa, sheet and plate . . . Cleveland, Ohio, castings . . . New Kensington, Pa., drawn tubing.

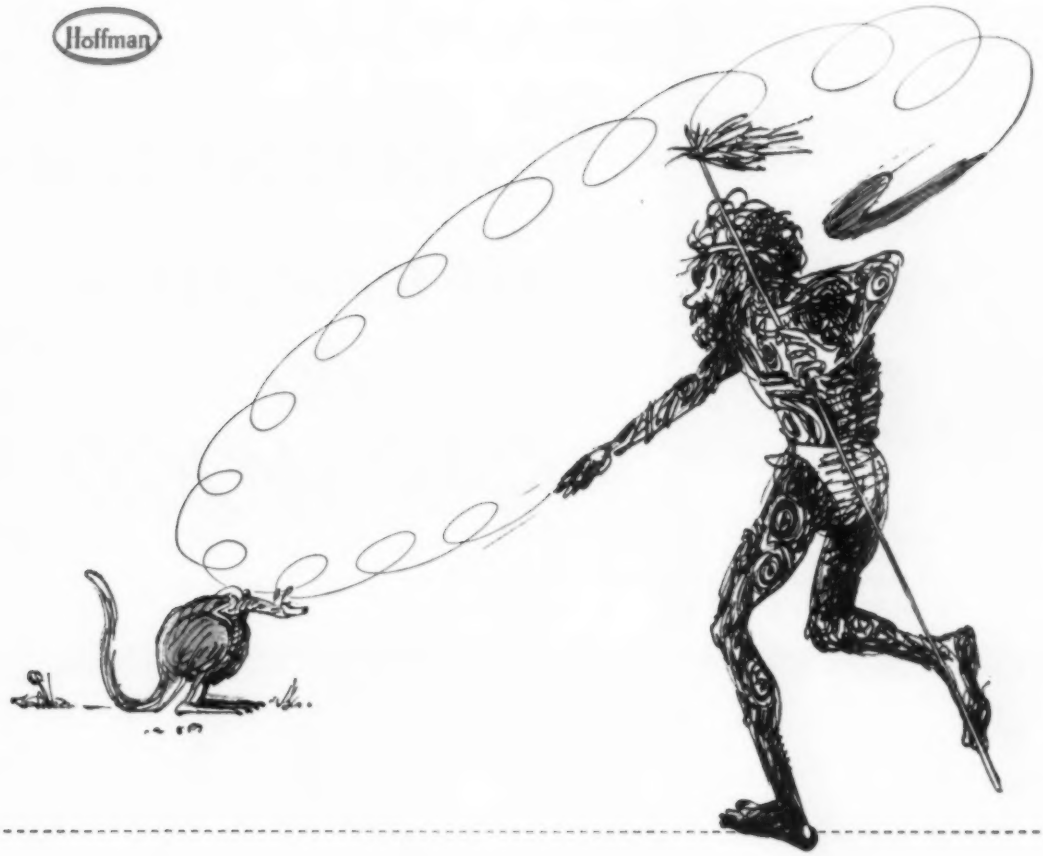
ALCOA possesses the world's greatest fund of aluminum knowledge. You're welcome to draw on it whenever you need help. Just call your nearest Alcoa sales office. Or write to: Aluminum Company of America, 2031-S Alcoa Building, Pittsburgh 19, Pa.

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM

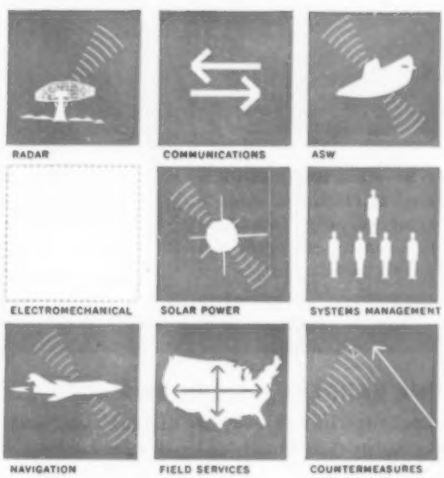
ALUMINUM COMPANY OF AMERICA

Hoffman



guidance problems?

Once a missile has left the launching pad, its success is dependent, in part, on the reliability of its guidance system—a system demanding an extremely high degree of precision. Hoffman's Electro-Mechanical Department employs the most advanced precision manufacturing techniques to produce gyroscopes, navigational computers, indicators, and other essential electro-mechanical instruments and components. Equipped with the tools and skills required for this highly exacting work, Hoffman's Electro-Mechanical Department stands ready to help solve your precision manufacturing problems.



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for ease of operation and maintenance GO GAR WOOD

GAR WOOD-ST. PAUL DUMP BODIES are reinforced to eliminate spreading, sagging or warping. Telescopic and arm-type hoists are preferred for smooth operation.

GAR WOOD WINCHES will never stick or freeze! Clutch is fully enclosed to keep rust, weather and dirt out. Self-engaging clutch prevents slipping.

GAR WOOD EXCAVATORS with independent travel let operator hoist or swing while moving. Compact machinery deck makes parts easily accessible.

EVEN THE HARDEST JOB CAN BE MADE EASY... by equipment that is easy to operate and easy to maintain. With Gar Wood, you get advanced features that give maximum ease of operation and maintenance. Check the complete line of Gar Wood truck equipment and construction machinery. Write to Customer Service Dept., Gar Wood Industries, Inc., Wayne, Michigan.

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INDUSTRIES, INC.
Wayne, Michigan

ALUMINUM IN THE AGE OF CHALLENGE

TODAY, U.S. MILITARY PLANNERS FACE THE GREATEST CHALLENGE IN THE HISTORY OF OUR NATION: THE BUILDING OF A MODERN, EFFICIENT FIGHTING FORCE CAPABLE OF STRIKING ANYWHERE IN THE WORLD AT A MOMENT'S NOTICE. ★ MOBILITY IS THE KEY TO MODERN MILITARY PLANNING. AT THE HEART OF MOBILITY LIE TWO SIMPLE PHYSICAL FACTS: (1) THE LIGHTER THE LOAD, THE FASTER AND FARTHER IT TRAVELS; AND (2) THE FEWER OBJECTS TO BE MOVED, THE LESS TIME, TRANSPORT AND FUEL IT TAKES TO MOVE THEM. ★ ALUMINUM HOLDS THE KEY TO MOBILITY. ★ REALIZING THE STRATEGIC IMPORTANCE OF ALUMINUM IN CURRENT MILITARY PLANNING, KAISER ALUMINUM HAS ESTABLISHED A SPECIAL DEFENSE INDUSTRY SALES DEPARTMENT WITHIN ITS NATIONWIDE ORGANIZATION OF 40 SALES OFFICES TO OFFER BOTH SALES AND TECHNICAL AID FOR EVERY ASPECT OF MILITARY PROCUREMENT AND PRODUCTION. TO RENDER THIS SERVICE, THE DEFENSE INDUSTRY SALES DEPARTMENT HAS AT ITS COMMAND THE VAST RESOURCES AND FACILITIES OF KAISER ALUMINUM.

PLEASE TURN PAGE.

HOW KAISER ALUMINUM HELPS YOU OF MILITARY PROCUREMENT

NATIONWIDE PRODUCTION FACILITIES. Kaiser Aluminum's plant system includes 25 facilities throughout the nation and abroad.

These facilities offer a completely integrated operation from the mining of bauxite in Jamaica to the final production of finished mill products such as sheet, plate, forgings, extrusions, and many others. Here are some important facts you should know about these facilities.

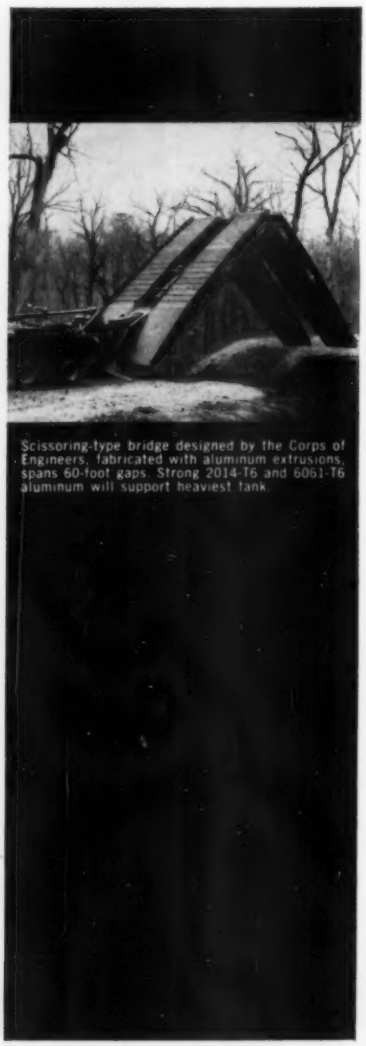
RAVENSWOOD – HOME OF THE 30-MILLION-POUND STRETCHER. At Ravenswood, W. Va., Kaiser Aluminum has recently completed the most modern integrated sheet and plate mill in the world.

One of the newest additions to this plant is a giant aluminum plate stretcher with the industry's greatest pull capacity – *30-million pounds!* The huge stretcher can handle plate 144" wide x 6" thick and 60' long, and opens up new opportunities in the fields of ordnance, cryogenics, naval ships, missiles and aircraft. Along with the 10-million lb. stretcher at Kaiser Aluminum's Trentwood, Washington, plant, the new stretcher makes possible the widest range of stretcher-leveled and stress-relieved sheet and plate in the industry.

Vacuum insulated 13,500 gallon air transportable liquid oxygen tank built of Kaiser Aluminum plate by the Standard Steel Corp., Cambridge Div., Lowell, Massachusetts.

THE INDUSTRY'S ONLY MATCHED HEAVY EXTRUSION PRESSES. At Halethorpe, Maryland, Kaiser Aluminum has two modern plants that together provide a completely equipped, fully integrated extrusion manufacturing operation.

Here are located the only matched heavy extrusion presses in the industry – two 8,000-ton presses. This duplication safeguards production by having tools completely interchangeable from one press to another in case one press breaks down. Also, these matched presses can produce unusual extrusions formerly considered impossible.



Scissoring-type bridge designed by the Corps of Engineers, fabricated with aluminum extrusions, spans 60-foot gaps. Strong 2014-T6 and 6061-T6 aluminum will support heaviest tank.

COMPLETE FORGING FACILITIES. With 31 pieces of heavy forging equipment – ranging from 1500 to 25,000 pound hammers and 750 to 8,000-ton presses – Kaiser Aluminum's Erie, Pa., plant offers one of the most complete forging facilities in the nation.

Aluminum forgings offer a high strength-weight ratio and excellent fatigue strength. They support extreme loads under rugged dynamic loading conditions, yet their light weight allows maximum mobility. Precision aluminum forgings hold close tolerances which reduce machining costs and makes aluminum competitive with traditional, low cost cast iron and steel forgings.

RESEARCH AND DEVELOPMENT. Kaiser Aluminum's Department of Metallurgical Research, Product Development Department, and other specialized technical staffs conduct continuous research resulting in new alloys and applications of particular value to the Defense industry.

Forged aluminum tank treads, produced at Erie, under contract with U.S. Army Ordnance Tank Automotive Command, Detroit, Mich., were successfully tested at Aberdeen – save 1,000 pounds per vehicle compared to steel.

MEET THE SPECIAL REQUIREMENTS AND MANUFACTURE

NEW HIGH STRENGTH WELDABLE ALLOYS. A major recent advance has been the development and introduction of new, weldable, high strength aluminum alloys by Kaiser Aluminum. The two new alloys, 5083 and 5086, provide maximum utility, joint strength and efficiency in welded structures, particularly those subject to impact or dynamic loading. These new alloys are now available in sheet, plate, forgings and extruded forms. The alloys, used with new welding techniques, have shown substantial design advantages over weldable aluminum alloys previously available. They also offer good forming properties, outstanding welding characteristics, excellent resistance to corrosion, and improved weld zone ductility.

The LARC-5, developed by the U.S. Army and the Borg-Warner Corp., is constructed of high strength, weldable Kaiser Aluminum alloys 5083 and 5086.

THE ONLY BALLISTIC FIRING RANGE IN THE INDUSTRY. As part of its extensive aluminum armor research program, Kaiser Aluminum has undertaken a program for testing armor plate by establishing a firing range for ballistic testing—the first such facility in the aluminum industry. Located at Spokane, Washington, the ballistic firing range conducts extensive tests on aluminum plate, extrusions, and forgings.

TECHNICAL AND MARKETING SERVICE. Kaiser Aluminum's field engineers, technical experts and Defense Industry specialists are at your service through any Kaiser Aluminum sales office. Also, Kaiser Aluminum offers complete marketing assistance to help you expand present markets and develop new ones. Why not take advantage of these services now? Whether you need product information or technical assistance, a phone call or letter will receive our immediate attention. Contact: *Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Drive, Oakland 12, California.*

M-113 aluminum armored personnel carrier achieves light weight for air transportability through use of Kaiser Aluminum alloy 5083 plate in hull section. Designed and built by Food Machinery & Chemical Corp.

FREE PORTFOLIO! *"Aluminum In The Defense Industry"* is a file folder packed with information on the many uses of aluminum for military applications. It includes information about the characteristics and properties of aluminum, important findings regarding alloys 5083 and 5086 as used in missiles, ground support equipment, cryogenics and other military applications, plus booklets on Kaiser Aluminum mill products availabilities and designing with aluminum. For your free portfolio, full of facts you can use – mail the coupon now!

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If you make it one at a time or by the millions

If you want to check its OD or its ID or a whole

lot of dimensions at once ...and if you want

the gage to indicate a dimension or flash a light

or ring a bell or a machine on the basis of tolerances

down to thousandths .001 or millionths .000001

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Corporation *Dayton 1, Ohio*

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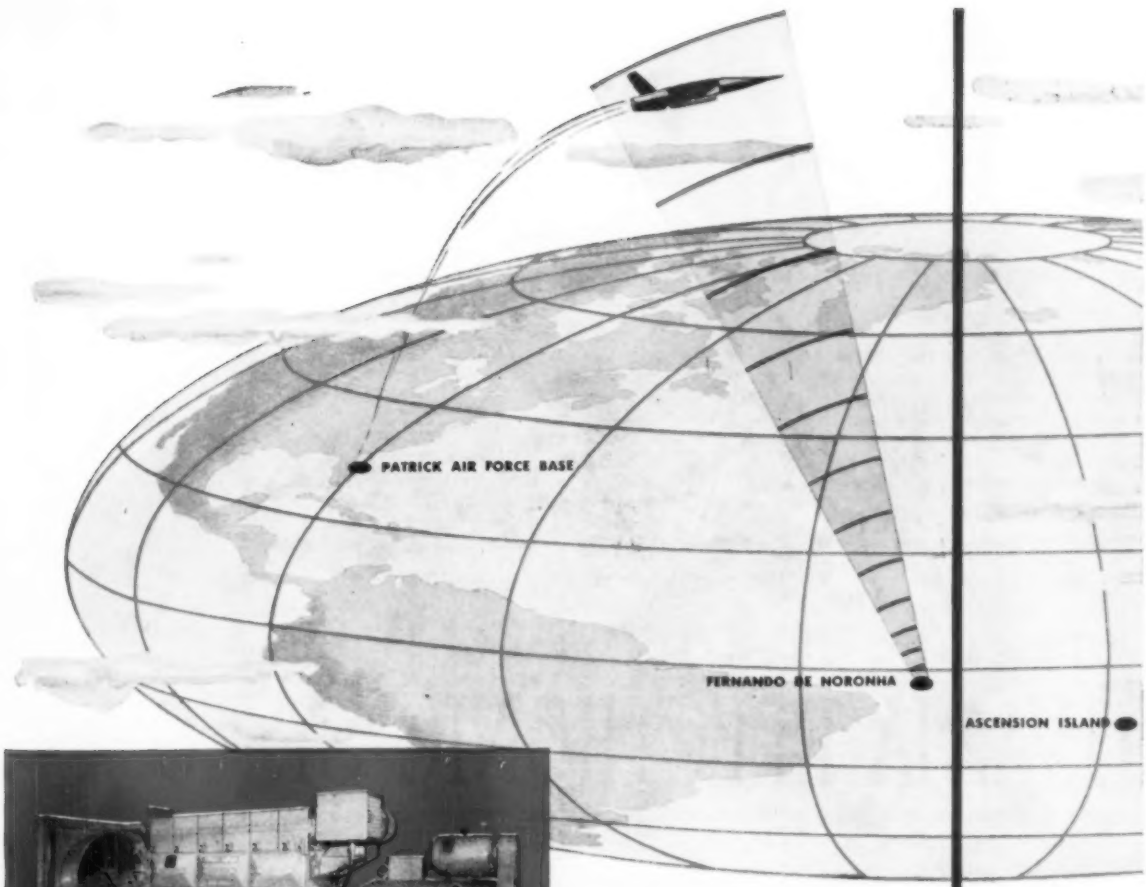

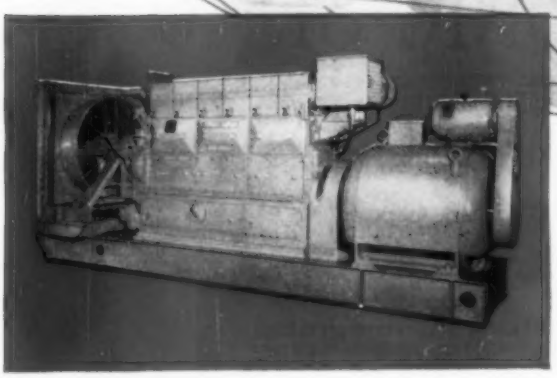

Powered by WHITE'S Superior Diesels

Down-Range Stations Track U.S. Guided Missiles

Along a 4,400 mile testing corridor sweeping from Florida southeastward to Britain's Ascension Island, U.S. guided missiles burn their way through tropical Atlantic skies. Radar eyes follow their flight from atop tiny rocky islands located hundreds of miles from any power station. The U.S.-built tracking and control stations fill gaps along the missile path . . . are watching, recording, and ready to explode the missile in air should its behavior become erratic!

Because the guided missile program is vital to U.S. defenses—yet must be conducted with full protection to lives and property—dependability of every piece of tracking equipment is doubly essential. Dependable White's Superior Diesel engines meet the U.S. Air Force requirements for supplying power on this down-range project. These high-quality, heavy-duty engines are world renowned for their continuous, dependable operation and easy starting. Superior's precision construction provides long, trouble-free performance with low maintenance and utmost fuel economy.

Other strategic U.S. defense installations are also Superior-powered, including the "Texas Towers," portions of "DEW" line and the "SAGE" project, Atlas and other launching stations, the Eglin Gulf Test Range and other missile tracking ranges. If your requirements range from 215 to 2150 HP or 150 to 1500 KW, benefit from White Superior's many advanced design features! *Get complete information now!*

Superior ENGINES ATLAS Imperial DIESEL ENGINES White DIESEL

White Diesel

WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY Plant and General Offices: Springfield, Ohio

This is

SYLVANIA ELECTRONIC SYSTEMS

now serving as Government systems managers for all subsidiaries of General Telephone & Electronics Corporation

Offering single source capabilities for integrated Communications–Data Processing–Electronic Display Systems

Now Sylvania–long experienced in the field of defense systems research, development and production–offers this far more comprehensive yet unified source of systems management and capability. Systems-oriented in concept and personnel, Sylvania Electronic Systems now integrates under one direction all the skills and facilities of one of the world's leaders in communications and electronics–General Telephone & Electronics, and its subsidiaries, including:

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HOW SYLVANIA ELECTRONIC SYSTEMS BENEFITS YOU: Sylvania Electronic Systems makes it possible to obtain complete defense systems of the highest quality, of specified performance, delivered on schedule at competitive costs. When you work with Sylvania Electronic Systems you enjoy the many advantages of:

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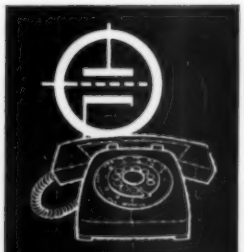
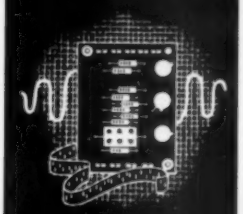
Quick-Reaction Capability • Efficiency • Financial Accountability • Experience



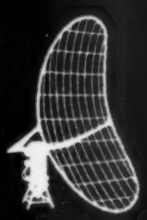
Communications Systems

SYLVANIA ELECTRONIC SYSTEMS offers skills and experience covering the complete electromagnetic spectrum in the media of air, space, water, ground. This integrated systems group includes the capabilities of the 32 domestic and international telephone operating companies in the General System. This group offers the most advanced equipment and development capabilities in dial telephone systems, automatic electromechanical and electronic switching systems, central office and terminal equipment, toll and exchange voice, telegraph, and data carrier transmission systems for wire, cable and radio applications, microwave relay and mobile radio systems and advanced low detectability and secure communications systems.



Data Processing and Display Systems

Sylvania leadership in digital data processing is typified by its most recent achievement: design and development of MOBIDIC. This solid state, mobile computer will give field armies real-time solutions to many intelligence and reconnaissance problems, almost instantaneous answers to operational problems involving logistics, inventory control, etc. Sylvania has also pioneered in developing electronically driven electroluminescent display equipments and systems. SYLVANIA ELECTRONIC SYSTEMS has subsystem management and development responsibility for the data processing portion of the Air Force BMEWS program, including new and advanced concepts of 3-dimensional data take-off circuitry and equipment.



Detection and Tracking Systems

SYLVANIA ELECTRONIC SYSTEMS has an advanced capability in high resolution, electronically scanned radar. Example: Sylvania has management and development responsibility for the Army's AN/MPQ-32, a mobile artillery detection, tracking and fire control system.

Intelligence and Reconnaissance Systems

In recent years, Sylvania has developed many types of broadband ferret receivers, signal analyzers and sensing devices across the entire spectrum. Advanced anti-intrusion devices are now under development. The Air Force AN/GLR-4 program represents the type of programs in this area for which Sylvania has development and management responsibility.

Electronic Warfare Systems

Sylvania leadership in electronic warfare is typified by its advances in countermeasures and counter-countermeasures against all known types of electromagnetic radiation. Sylvania manages the passive defense system for the B-58, and maintains a quick-reaction capability and facility for Army ground-based electronic warfare activities.

FOR FULL INFORMATION on how Sylvania Electronic Systems might be of special service to you, please call or write Sylvania Electronic Systems, a Division of Sylvania Electric Products Inc., Waltham, Massachusetts.

SYLVANIA ELECTRONIC SYSTEMS
Government Systems Management
for GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

EVEN ON THIS EXTRA-TOUGH JOB...

N-A-XTRA

HIGH-STRENGTH STEEL TRIPLES TRUCK LIFE!

Hour after hour, around the clock, the Edward C. Levy Slag Company, Detroit, keeps forty 45-ton trucks working under severe conditions. Nearly 30 tons of hot slag are loaded, lifted and dumped on every trip. Each time, the truck body must stand the sudden shock of drop loading, the stress of lifting that load and the grinding abrasive action as it empties.

How long can a truck body take such a beating?

Until the company (which designs its own trucks) discovered N-A-XTRA high-strength steel, they used ordinary carbon steel, good for about 18 months' service. Though the truck bodies were as strong as they could be and still carry an adequate payload, maintenance was almost continuous—with breaks, dents, dings and sags occurring almost from the start.

Then they fabricated eight bodies out of N-A-XTRA, which has a minimum yield strength nearly three times greater than mild carbon steel. These trucks carry the same payload and after 18 months' service still look almost new. Owners estimate a life of five years, more than triple the others—with far less maintenance. The extra strength of N-A-XTRA also permits a strong floor that needs no expensive reinforcement to support the load against hydraulic lift action.

Eventually, all forty Edward C. Levy trucks will be made of N-A-XTRA high-strength steel. In fact, all patches and section replacements are now made with N-A-XTRA.

Tons of hot, abrasive slag may not be your problem—but the same steel that mastered these conditions is the one to remember when only the strongest steels will do. Rugged conditions, heavy loads and weight-saving construction are challenges that N-A-XTRA is designed to meet and beat. With excellent weldability, formability and toughness, these quenched and tempered N-A-XTRA steels are available in four levels of minimum yield strength, from 80,000 to 110,000 psi. They can also be supplied to higher levels of mechanical properties.

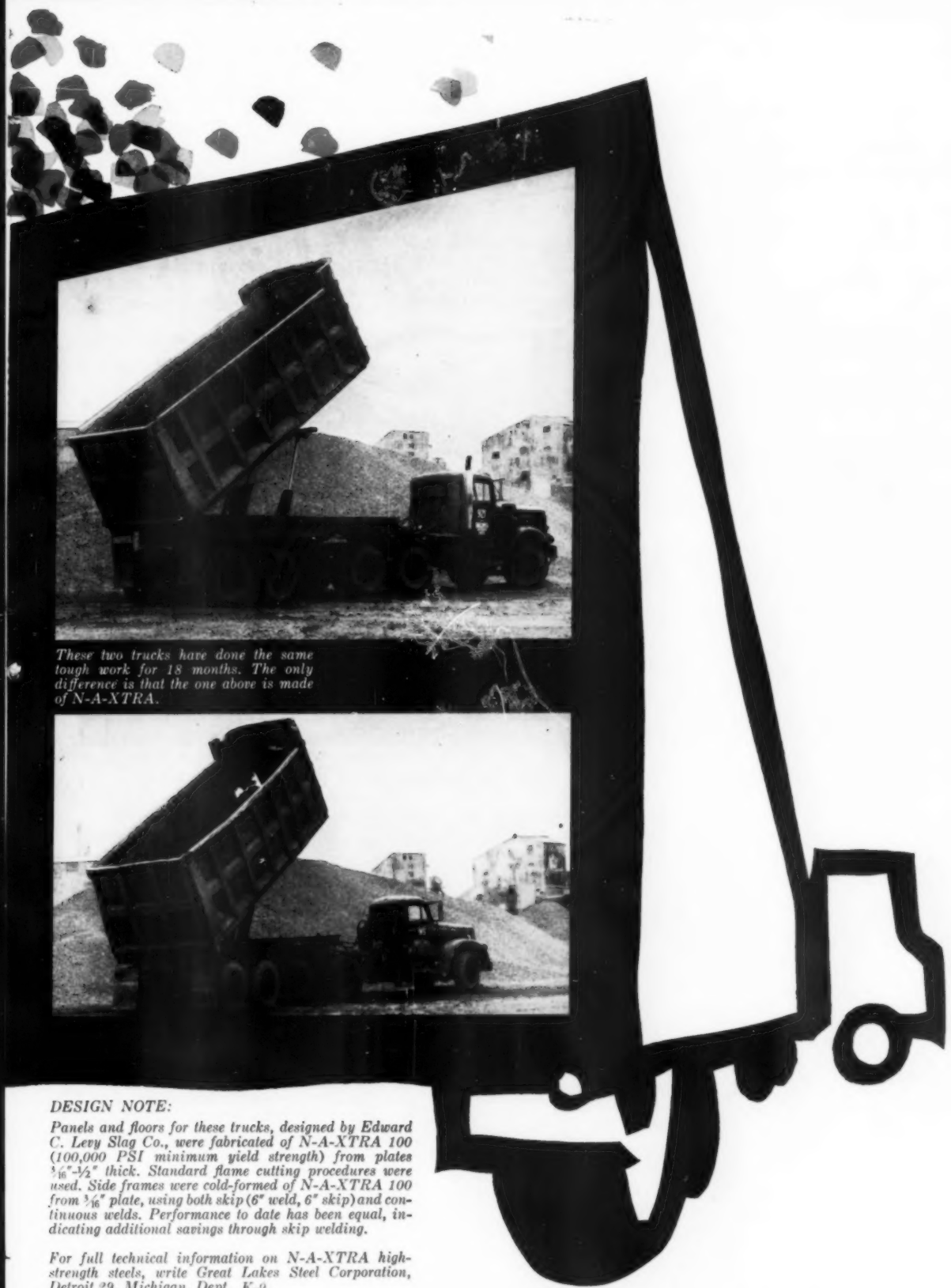
Dramatic contrast! Compare above truck interior of N-A-XTRA high-strength steel with the mild carbon steel body and its reinforced floor.

N-A-XTRA

A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan



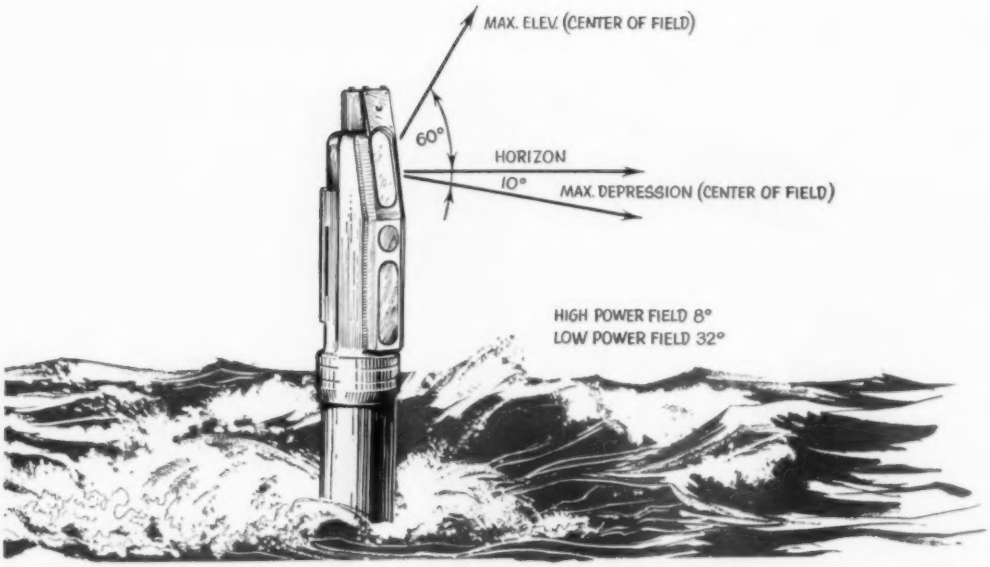
These two trucks have done the same tough work for 18 months. The only difference is that the one above is made of N-A-XTRA.

DESIGN NOTE:

Panels and floors for these trucks, designed by Edward C. Levy Slag Co., were fabricated of N-A-XTRA 100 (100,000 PSI minimum yield strength) from plates 5/16"-1/2" thick. Standard flame cutting procedures were used. Side frames were cold-formed of N-A-XTRA 100 from 5/16" plate, using both skip (6" weld, 6" skip) and continuous welds. Performance to date has been equal, indicating additional savings through skip welding.

For full technical information on N-A-XTRA high-strength steels, write Great Lakes Steel Corporation, Detroit 29, Michigan, Dept. K-9.

***Great Lakes Steel is a Division of* NATIONAL STEEL CORPORATION**

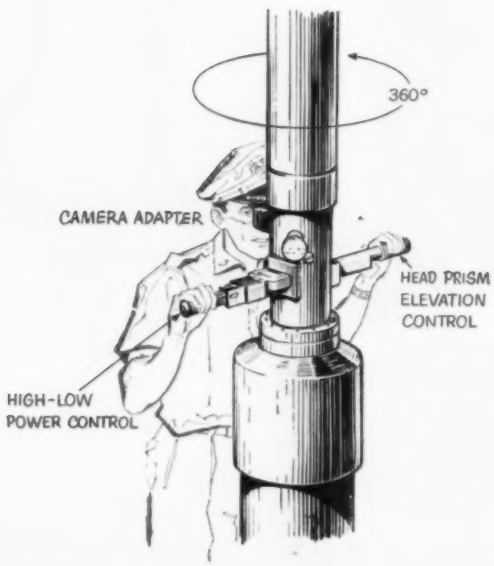


The Nuclear Navy has Kollmorgen eyes

The USS NAUTILUS and her sister subs in our nuclear navy are each fitted with two or three modern periscopes designed and manufactured by Kollmorgen. These naval "eyes" are precise optical instruments over forty feet long with controls and components that solve difficult problems of viewing, computation and tactics.

Kollmorgen has had notable successful experience developing optical inspection and alignment equipment. High speed projection lenses, industrial periscopes, mechanical and electronic controls for viewing instruments are all typical of advanced Kollmorgen production.

Write on your company letterhead for a fully illustrated, twenty-four page brochure describing Kollmorgen's experience, skills and facilities.



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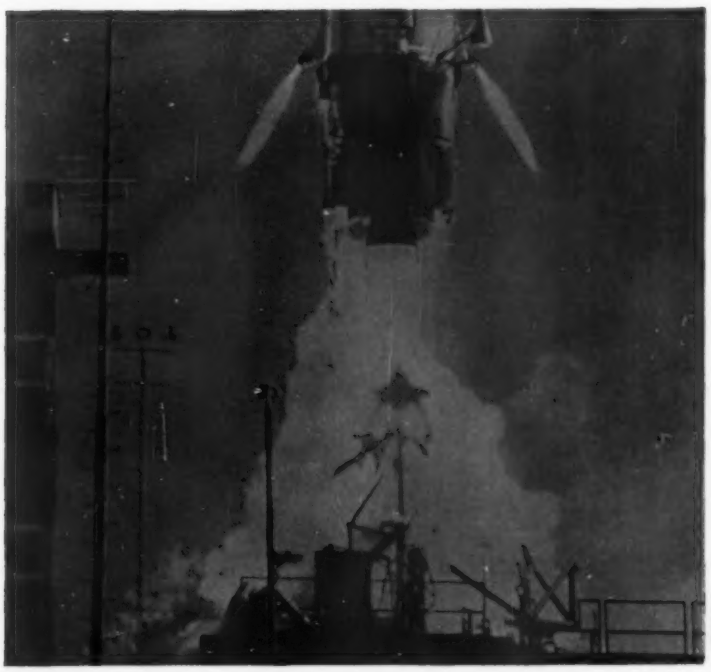
To the moon and back and wherever missiles fly. Librascope computers deliver ready answers for in-flight control ■ guidance, optimum trajectories, impact prediction, data reduction and analysis. Throughout flight... Librascope missile computers are uninterrupted by environmental extremes...and they will automatically and continuously check their own built-in accuracy. The compact size, minimum weight and performance of Librascope missile computers have earned them important roles in our conquest of space. For information on how Librascope advanced computer capabilities can answer your particular needs, write to Librascope, 808 Western Ave., Glendale, Calif. ■ Librascope, A Division of General Precision, Inc. ■ For information on engineering career opportunities, contact Glen Seltzer, Employment Mgr.

computers that pace man's expanding mind



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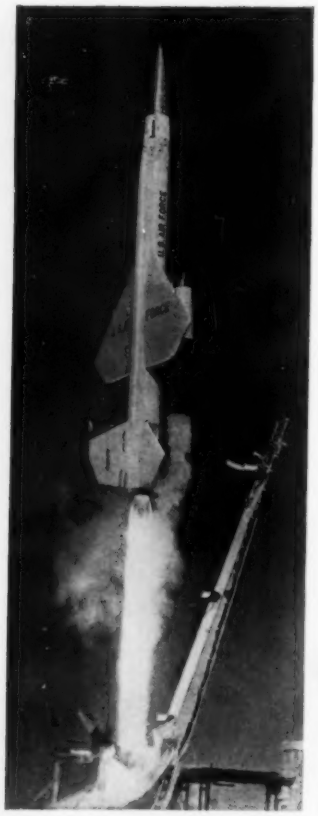


KEARFOTT developed

and now produces

the Bomarc-B all-attitude

mid-course

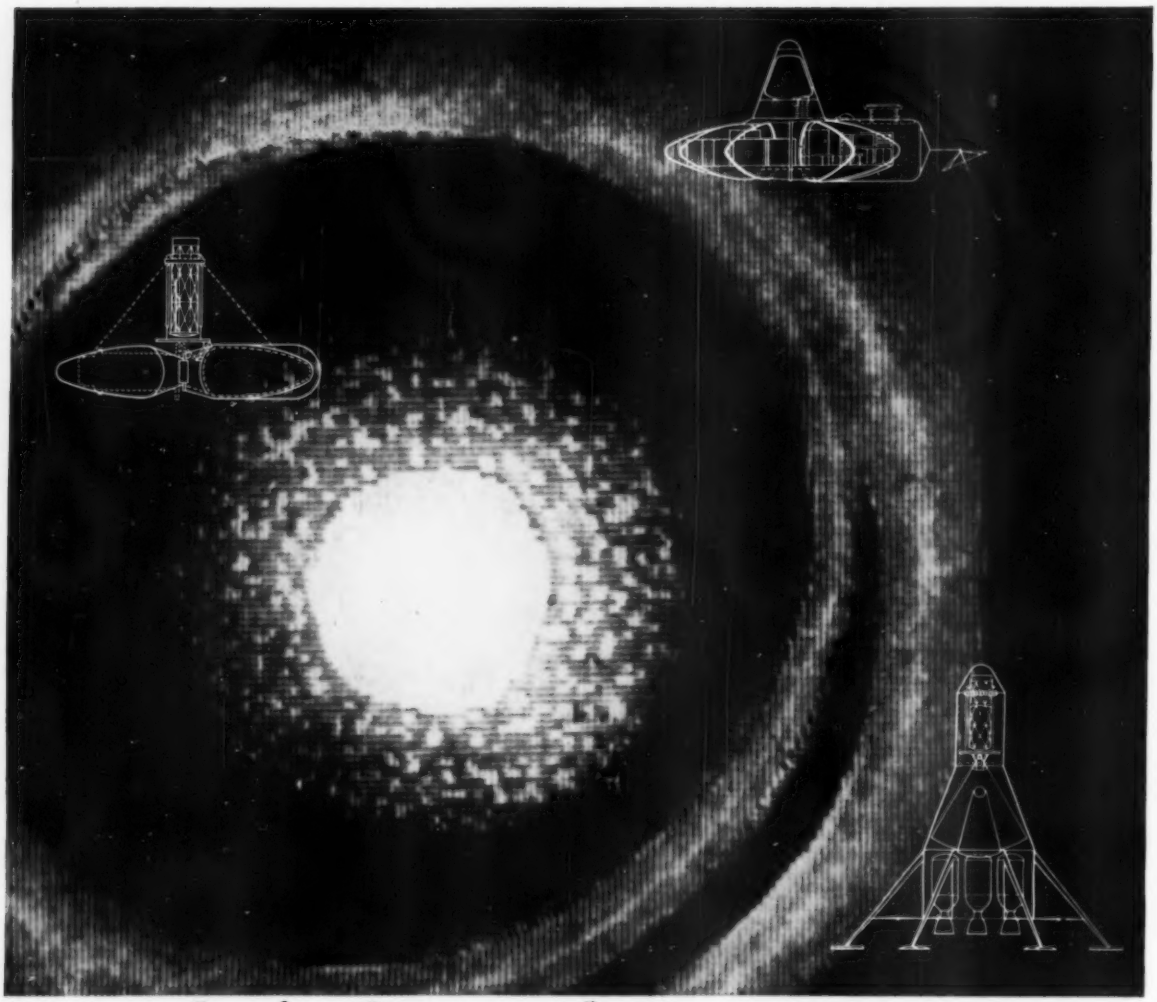
guidance system.

Engineers: *Kearfott offers challenging opportunities in advanced component and system development.*

KEARFOTT DIVISION
LITTLE FALLS, NEW JERSEY

GENERAL PRECISION, INC.
OTHER DIVISIONS OF GENERAL PRECISION INC. – GPL-LIBRASCOPE-LINK

NEW REACTOR DEVELOPED
by AEROJET
Attainment of criticality by the Gas-Cooled Reactor Experiment in Idaho is a step forward towards compact, transportable nuclear power plants. This facility to test advanced concepts for mobile power reactors was designed and developed by Aerojet-General Nucleonics, San Ramon, California, and the Aetron Division of Aerojet-General Corporation, for the U. S. Atomic Energy Commission. As systems contractor for the Army Gas-Cooled Reactor Systems Program, Aerojet is designing the world's first mobile power plant.
Aerojet-General
CORPORATION
Plants at Azusa, Downey, San Ramon and near Sacramento, California, Frederick, Maryland
A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY



New styles for the man-about-space

Every time a space traveler leaves home (earth), he has to wrap himself in the complete environment necessary to his physiological and psychological well-being. Styling sealed space capsules to suit man's every requirement has been a major project at Douglas for more than ten years. Forty basic human factors areas were explored in these studies. Now Douglas engineers have evolved plans for practical space ships, space stations and moon stations in which men can live and work with security thousands of miles from their home planet. The company's wide experience in producing large rocket and pressurized aircraft systems has provided it with unmatched capabilities in the missile and space fields.

Dr. Eugene Konecci, Head, Life Sciences Section, reviews a new concept in space cabin design with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB® ■ GROUND SUPPORT EQUIPMENT

DOW | *Now in magnesium and aluminum*

NEW MAGNESIUM DEVELOPMENTS ANSWER DESIGNERS' PROBLEMS

New Dow Developments in Magnesium Provide Solutions to Critical Problems for Designers of Ground Support Equipment; Among these are: Special Bend Sheet; Closer Sheet Tolerances; Precision Extrusions; Intricate Castings.

Heated dies are not necessary with Special Bend sheet.

NEW SPECIAL BEND SHEET bends easily on standard bending equipment at room temperature. This AZ31B-O Special Bend sheet can be cold-bent without cracking through an angle of 90 degrees around a mandrel radius equal to the bend factor times the nominal sheet thickness . . . bend factor for .040″ to .100″ sheet thickness is 2.0! And tensile yield strength meets the requirements of Federal Specification QQ-M-44.

NEW CLOSE SHEET TOLERANCES can now be obtained on standard gauges when required. For example, on .090″ gauge, 48-inch-wide sheet, tolerances can now be held as close as plus or minus .002″. Standard tolerances run plus or minus .004″. These closer tolerances help to cut down on weight penalty, so important in air transportable equipment.

PRECISION MAGNESIUM EXTRUSIONS from Dow give you exact-tolerance parts without costly multiple machining operations. Sharp V's, deep notches, thin slots, accurate serrations . . . all can be economically produced in Dow's Madison, Illinois, extrusion plant.

LARGE EXTRUSIONS. A huge 13,200-ton press easily handles large sections, stepped extrusions, combined extrusion forgings and single unit extrusions to replace fabrications. This giant can handle sections of up to a 30-inch circumscribed circle!

INTRICATE CASTINGS. Complex designs, close tolerances, thin sections (production castings can be made with wall as thin as 0.100″ ± 0.010″), cast-in tubeless passageways: these are but a few of the advantages that are available to you from Dow's sand and permanent mold foundry.

Compared pound for pound with other metals, magnesium permits the use of heavier-gauge, more rigid sections for extra structural strength . . . and substantial weight savings!

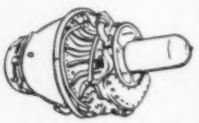
Magnesium gives greater rigidity for equal weight than other metals.

Castings from Dow's foundry range from small precise parts like these, to massive units weighing hundreds of pounds.

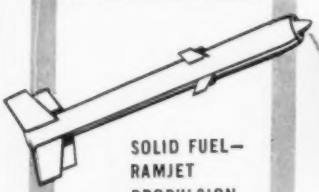
For more information on these products, and on Dow's fabrication facilities for magnesium and aluminum, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1021DF5.

See "The Dow Hour of Great Mysteries" on NBC-TV

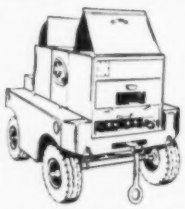
DOW **THE DOW METAL PRODUCTS COMPANY**
Division of The Dow Chemical Company



TURBINE PROPULSION



SOLID FUEL—
RAMJET
PROPULSION



GROUND SUPPORT

CAE POWER

- Research
- Development
- Production

● Continental Aviation & Engineering Corp. is exceptionally well qualified, both by experience and by facilities, for work on the weapons systems of tomorrow. Our background embraces not only a half-century of internal combustion engine experience, but also years of pioneering in gas turbine engine development, and more than a decade in the field of solid fuels for ramjet propulsion of missiles and target drones . . . Continental is staffed and equipped for a wide range of assignments, military and commercial. The Detroit Division Research and Development Department is supported by our modern-to-the-minute Component Testing Laboratory complete with environmental facilities located at Toledo. The Toledo Production Division now producing various turbine engines in volume is capable of supporting diversified programs . . . The CAE record of achievement is one of which many a larger company might be proud. Inquiries are invited from those having propulsion problems, on the ground, on the water, in the air.

CONTINENTAL AVIATION & ENGINEERING CORPORATION

GENERAL OFFICES AND RESEARCH AND DEVELOPMENT DEPARTMENTS AT 12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN . . . PRODUCTION DIVISION AND FIELD SUPPORT, 1330 LASKEY ROAD, TOLEDO, OHIO.

SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

ATOMIC ENERGY

New Reactor Experiments

Los Alamos Scientific Laboratory has reported to the Atomic Energy Commission the status of technical preparations for field tests of experimental nuclear rocket reactors to be conducted this summer in the Rover program, a joint Atomic Energy Commission-National Aeronautics and Space Administration program to develop a nuclear rocket engine.

The initial program phase—demonstration of the feasibility of nuclear rockets by ground operation of an experimental engine—is being conducted under the management of the AEC. The second phase—flight test of a rocket engine at a site yet to be determined—will be conducted under NASA management.

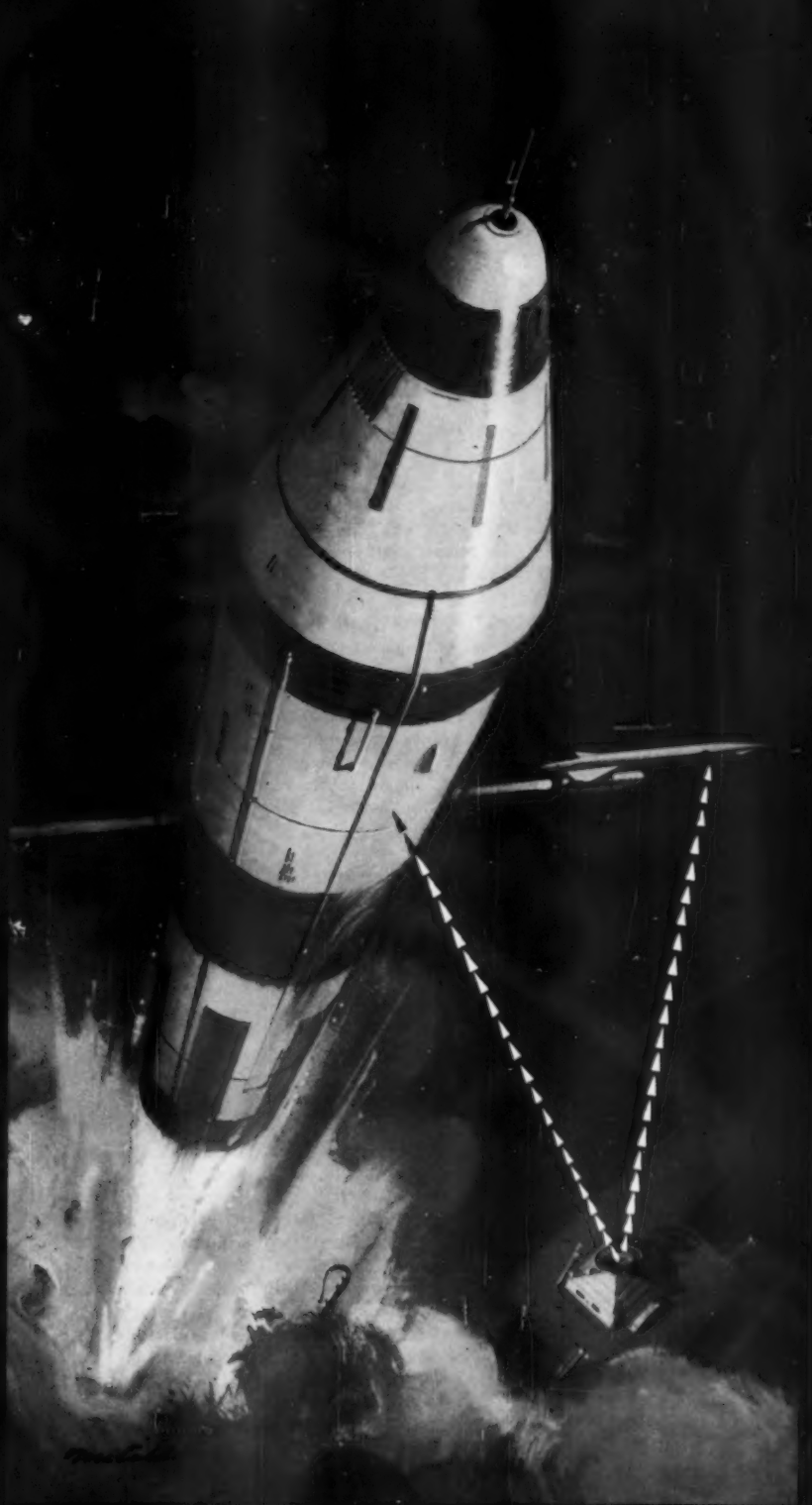
The AEC portion of the program, which will be carried out over a period of about five years, will be conducted at the Nevada Test Site and will include the test of several reactors, some of which will be improved designs advanced beyond those to be operated in the initial program phase.

Two reactors will be tested at the Nevada Test Site in what is being called the Kiwi-A Prime series. These two reactors are outwardly similar to Kiwi-A, nearly identical to each other, and are designated Kiwi-A Prime and Kiwi-A3. Both will use the same test cell and other facilities. The original Kiwi-A has been reassembled and hooked up to the test cell at the Nevada Test Site without nuclear components and will be used as a mock-up in nonnuclear cold-flow experiments in preparation for tests of the two new reactors.

Work also is proceeding on a new test cell at the Nevada Test Site which is scheduled for completion early in 1961. This new cell will be similar in design to the existing cell but will permit more extensive exploratory testing of complete rocket engines.

Indirect-Cycle Reactor Test

The Atomic Energy Commission has awarded the Blaw-Knox Company, Pittsburgh, Pa., a contract to study the facilities required for testing an experimental indirect-cycle aircraft reactor. Purpose of the study is to establish a basis for determining the most economical and practical method of providing the facilities needed for the testing program to be conducted as part of the Commission's aircraft nuclear-propulsion program. The study will also provide a basis



New from Crosley...
miniaturized
Command Receivers for missiles and drones

To meet the critical need for high-density packaging in missiles, Avco's Crosley Division has developed new miniaturized Command Destruct Receivers that weigh only three pounds.

Their task: To receive and act upon instruction from the ground to destroy a missile that has gone out of control.

In the Command Destruct configuration for range safety and similar applications, the miniaturized Command Receiver has four channels incorporating a decoder, to provide a secure link between the ground station and missile.

For high-performance drones and decoys, there are similar miniaturized Command Receivers that employ a 12-channel network. These receivers will actuate control surfaces, direct engine operation, and open a recovery parachute—all by radio-conveyed ground instruction.

Today Avco/Crosley Command Receivers are standard equipment on most of the nation's missiles. And by meeting the most severe environmental and operational requirements they have proved themselves for the future.

For more information, write to Vice-President, Marketing-Defense Products, Dept. O-CR, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio

New Crosley Command Receiver is about the size of a kitchen match box.

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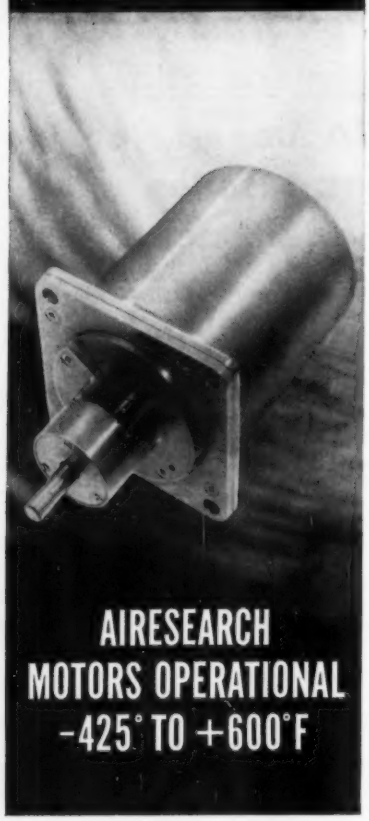
Electromechanical Components and Systems Capability



AIRESEARCH MOTORS OPERATIONAL -425° TO +600°F

Specialized aircraft motors developed by AiResearch operate at temperatures from −425° to +600° F. ambient. The range of this compact, lightweight, ½ H.P. motor is −65° to +600° F.

AiResearch diversification and experience provide full capability in the development and production of electromechanical equipment and avionic controls for aircraft, ground handling, ordnance and missile systems.

A.C. and D.C. Motors, Generators and Controls • Inverters • Alternators • Linear and Rotary Actuators • Power Servos • Hoists • Electrical Pyrotechnics • Antenna Positioners • Positioning Controls • Temperature Controls • Sensors • Williamsgrip Connectors • Static Converters.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

Atomic Energy (Contd.)

for the development of design criteria for new facilities or the modification of the existing facilities that may be required.

An indirect-cycle reactor is being developed by the Pratt & Whitney Aircraft Division of United Aircraft Corporation, Middletown, Conn., for the Commission and the United States Air Force. All existing aircraft nuclear propulsion program facilities at Idaho were designed for and are currently being used in the development of a direct-cycle aircraft reactor by the General Electric Company, also for the Commission and the Air Force.

The General Electric Company has been conducting this testing program at the National Reactor Testing Station since 1956. The Pratt & Whitney program has been conducted on a developmental research level since 1951.

SPERT-II Facility

The Special Power Excursion Reactor Test No. 2 (SPERT-II), a versatile facility developed for studying nuclear reactor safety, recently achieved criticality at the Atomic Energy Commission's National Reactor Testing Station near Idaho Falls, Idaho.

SPERT-II was constructed for the Commission by Paul Hardeman, Inc., of Los Angeles, Calif. Phillips Petroleum Company, which is operating the facility for the Commission, furnished the conceptual design, the design and fabrication of the control system, and the design of the instrumentation. Stearns-Roger Manufacturing Company, Denver, Colo., prepared the detailed design. Total cost of the facility, including equipment and heavy water, is approximately $4,000,000.

SPERT-II is one of a series of reactors developed for the Commission by Phillips as part of a program to find basic explanations for reactor behavior under runaway conditions. Its primary purpose is to provide the means of determining how various moderator and reflector materials influence reactor behavior.

Uranium Production

Statistics on domestic uranium production for the last six months of calendar 1959 were announced recently. Domestic ore reserves were estimated to total 86,100,000 tons on December 31, 1959. In addition, ore stockpiles totaled 1,449,069 dry tons as of December 31, 1959. Ore receipts at all private plants and Government purchase depots, July to December 1959, totaled 3,614,000 dry short tons; and ore fed to process totaled 3,623,000 tons, with an average grade of 0.24 per cent U_3O_8. Uranium concentrates received at the Grand Junction depot totaled 7,899 tons of U_3O_8 in the 6-month period.

As of January 1, 1960, there were 25 uranium processing mills operating in the Western United States, including the Cotter Corporation mill at Canon City, Colo., which was being enlarged from a pilot plant to a 200-ton-a-day mill. One Wyoming mill (Globe Mining Company) had started up, but the first concentrate was not delivered to the AEC until early February 1960. The only Government-owned mill, at Monticello, Utah, was closed at the end of calendar 1959. The combined rated daily capacity of the 25 mills was 22,100 tons of ore a day, and their total estimated capital investment was about $142,000,000.

A-Power in the Arctic

The governments of the United States and Denmark plan to install and operate a portable nuclear reactor to provide year-round heat and power at the U. S. Army's Camp Century on the Greenland ice cap. The reactor known as the PM-2A, will be the first remote-area installation of "portable" atomic power in the free world.

The pressurized-water, prefabricated nuclear power station will be installed later this year in snow tunnels at Camp Century. The site is an advanced base of the Army's Polar Research and Development Center and will be manned by approximately one hundred engineers and scientists who will be conducting research studies on the ice cap.

The PM-2A is being built by Alco Products, Inc., at its Dunkirk, N. Y., plant under a $3,226,560 contract let in January 1959, by the Eastern Ocean District Army Corps of Engineers. The power plant will deliver about 1,500 kilowatts of electricity for power and space heat plus about 1,000 pounds of steam an hour to be used for purification. The plant will be delivered to the Army at Dunkirk on May 20, 1960, after which it will be shipped to the site in approximately twenty-seven air-transportable packages. Operation is scheduled to begin late this summer.

At remote sites which must be supported by airlift, the delivered cost of diesel fuel exceeds one dollar a gallon. The estimated annual requirement for a diesel-fueled plant, comparable in capacity to the PM-2A, would be approximately 1,000,000 gallons. In contrast, it is estimated that the PM-2A will operate for twelve months on less than a single plane load of enriched uranium fuel.

Radioactive Material to Russia

The Atomic Energy Commission has approved the export to Soviet Russia of a small quantity of radioactive by-product material for scientific, nonmilitary use.

(Continued on p. 844)

Multi-Use
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MPTE

The recent demonstration of multi-purpose test equipment (MPTE), developed by RCA under a series of Army Ordnance contracts, highlights *a new dimension in automated multi-use systems support* and culminates a long-term RCA effort in this field. This General Evaluation Equipment is an automated, transistorized, dynamic checkout system. It contains a completely modularized array of electronic and mechanical evaluation equipment, capable of checking a variety of electromechanical devices, ranging from radar subassemblies to missile guidance computers. MPTE provides the stimuli, programming, control, measurement and test functions for the NIKE AJAX, NIKE HERCULES, LACROSSE, HAWK and CORPORAL missile systems and has been extended to other weapons systems related to our defense efforts.

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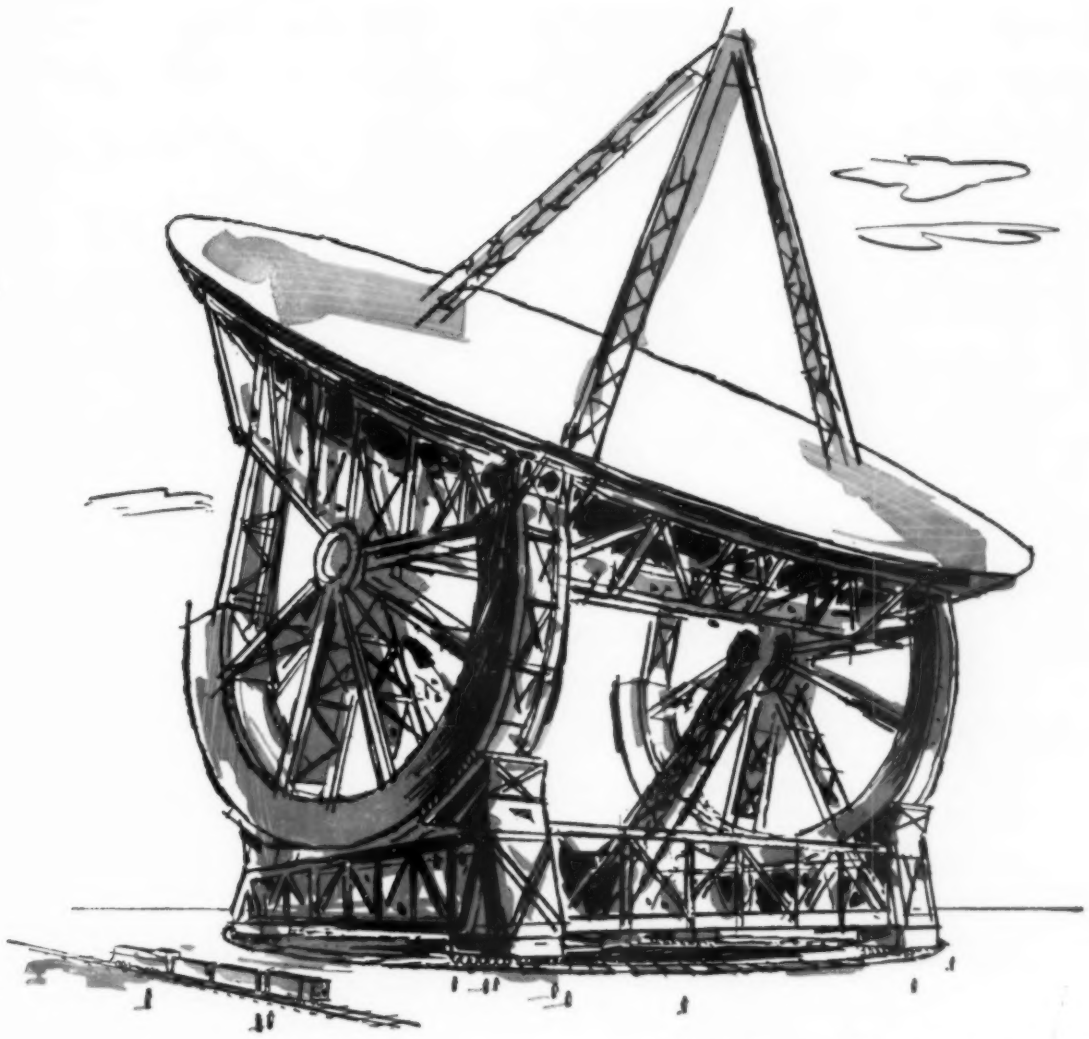

Huge radio telescope for celestial exploration and space communication. Note how freight train is dwarfed by it.

Loewy plays vital role in design and construction of world's largest radio telescope

Loewy-Hydropress, well established in the design and construction of testing and launching installations for missiles and rockets, has extended its activities into the field of radio telescopes and allied equipment. Loewy is currently making a major contribution to the world's largest telescope (now under construction for the U.S. Navy) by designing and building the huge bearings, drives, supports and other mechanical elements which motivate altitude and azimuth position and control the fine balance of the structure.

In addition to the Navy project, Loewy engineers have been working on another enormous telescope, one with a reflector diameter of approximately 300 ft. And they have also been instrumental in the development of the complex mechanisms and structures for large radar tracking antennas.

For information that could be helpful in your structural and mechanical problems concerning radio telescopes and radar antennas for scientific and ordnance requirements, write Dept. H-5.

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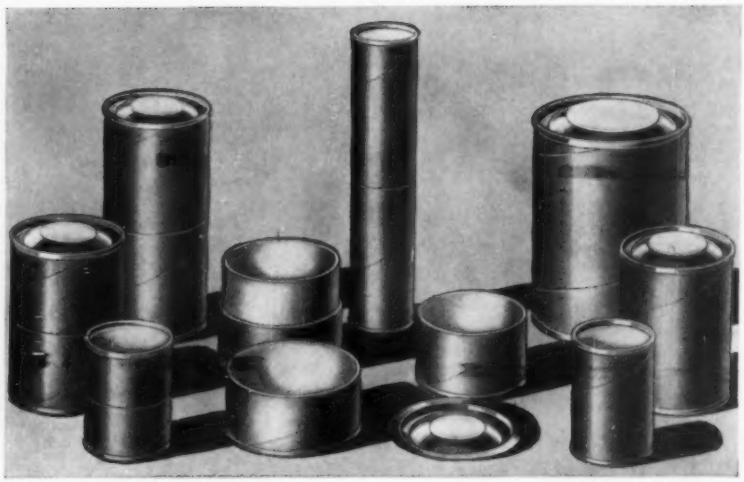

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Atomic Energy (Contd.)

Commission regulations require that a specific export license approved by the Commission be issued for export of by-product material (radioisotopes) of atomic numbers 3 to 83 to Soviet bloc countries and for export of polonium 210, tritium, or other by-product material with atomic numbers less than 3 or more than 83, to any country.

The New England Nuclear Corporation, Boston, Mass., applied for a license to export a hormone containing five microcuries of carbon 14 to Dr. Nicolai Yudaev, of the Institute of Biology and Medicine, Academy of Medical Sciences, Moscow. The material (Estradiol-17B-4-C^{14}) is intended for use in the study of biosynthesis of steroids using adrenal slices, or a study of some of the chemical products of the adrenal gland.

Project Gnome

The AEC has approved initiation of construction and site preparation for Project Gnome in the salt beds known as the Salado Formation about twenty-five miles southeast of Carlsbad, N. Mex. The project is part of the Commission's Plowshare Program to investigate the feasibility of using nuclear explosives for peaceful purposes.

During the current nuclear test suspension negotiations in Geneva, the U. K., the U. S., and the U.S.S.R. have agreed in principle on the use of nuclear explosions for peaceful purposes. The scientific results of Project Gnome, like all Plowshare projects, will be made available on a worldwide basis.

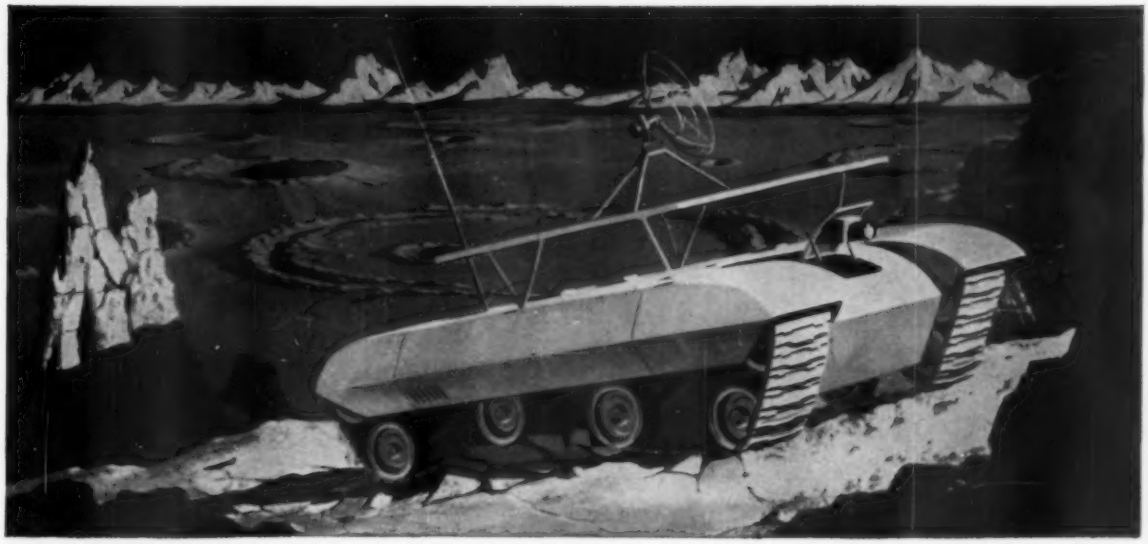
The construction phase of the project calls for a shaft 1,200 feet deep and, leading off from the bottom of the shaft, a tunnel 1,100 feet long in which a nuclear explosive of about 10-kiloton yield, the equivalent of 10,000 tons of high explosive, would be detonated. The construction is estimated to cost about $1 million and is expected to take about one year. Final authorization to detonate the nuclear explosive will be the decision of the President. The experimental objectives of the project are fourfold:

1. Explore the feasibility of converting the energy from the nuclear explosive into heat for the production of electric power.

2. Investigate the practicability of recovering useful radioisotopes for scientific and industrial applications.

3. Expand the data on characteristics of underground nuclear detonations to a new medium (salt) which has marked differences from the tuff (a volcanic rock) at the Nevada Test Site in which previous underground detonations were made.

4. Make neutron cross-section measurements which will contribute generally to scientific knowledge and to the reactor-development program.



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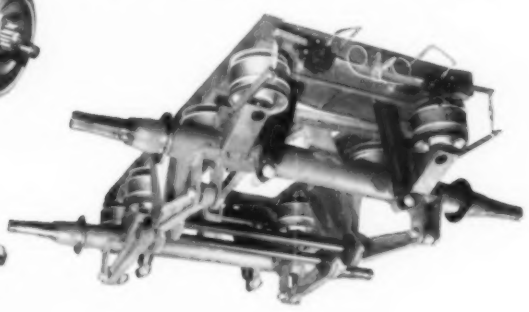

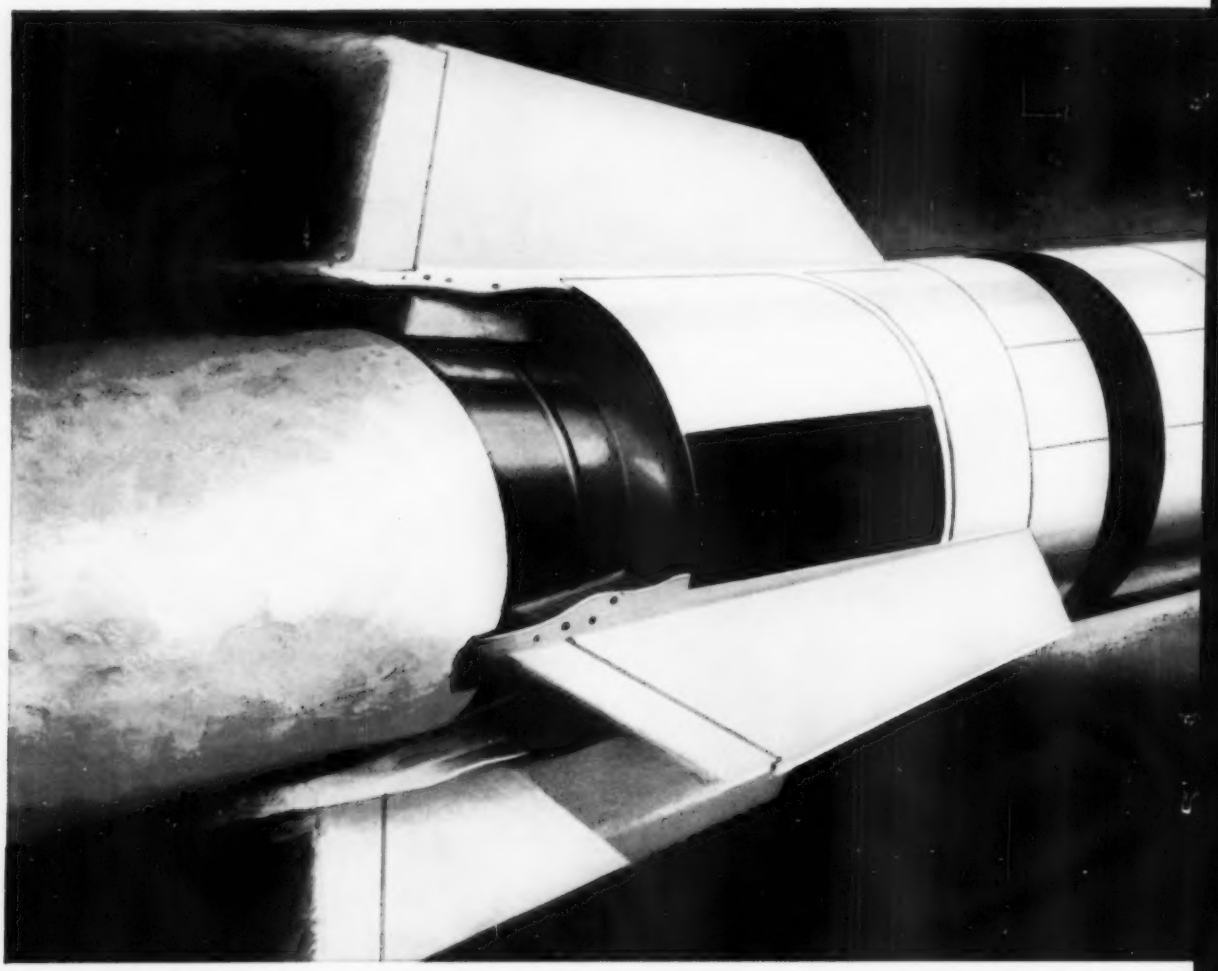

Off the pad

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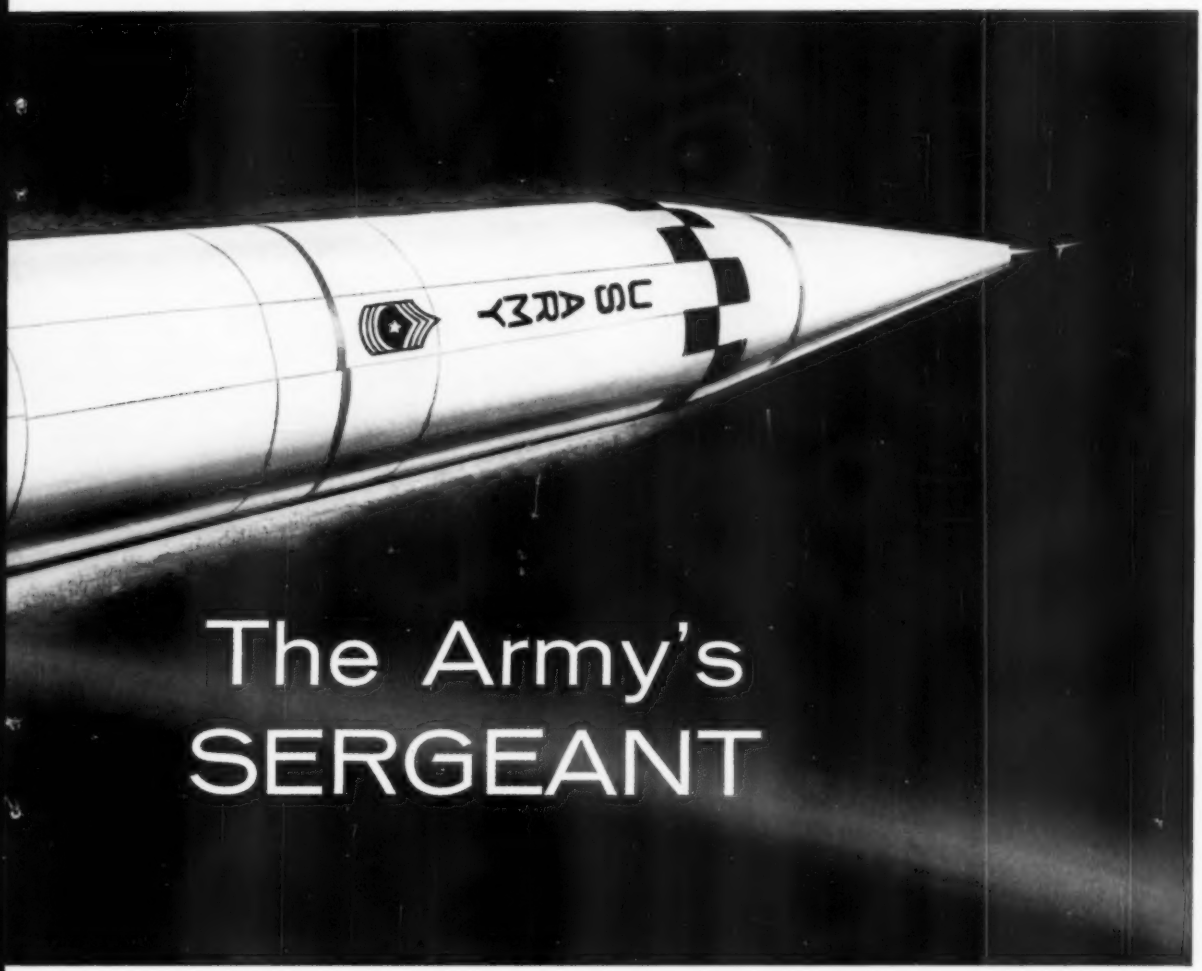

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On target

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HAROLD S. BLACK, LAMME MEDALIST

A MAN WINS A MEDAL...AND STRENGTHENS A PHILOSOPHY

The search for the "hitherto unattainable" sometimes ends in strange places.

For years Bell Laboratories engineer Harold S. Black pondered a problem: how to rid amplifiers of the distortion which unhappily accumulated as signal-transmission paths were made longer and amplifiers were added. There had been many approaches but all had failed to provide a practical answer.

Then one day in 1927 the answer came—not in a research laboratory, but as he traveled to work on the Lackawanna Ferry. On a newspaper, Mr. Black jotted down those first exciting calculations.

Years later, his *negative feedback principle* had revolutionized the art of signal amplification. It is a principal reason why telephone and TV networks can now blanket the country, the transoceanic cable is a reality, and military radar and missile-control systems are models of precision.

For this pioneer achievement, and for numerous other contributions to communications since then (some 60 U. S. patents are already credited to him), Mr. Black received the 1957 Lamme Medal from the American Institute of Electrical Engineers. He demonstrated that the seemingly "unattainable" often *can* be achieved, and thus strengthened a philosophy that is shared by all true researchers.

He is one of many Bell Telephone Laboratories scientists and engineers who have felt the challenge of telephony and have risen to it, ranging deeply into science and technology. Numerous medals and awards have thus been won. Two of these have been Nobel Prizes, a distinction without equal in any other industrial concern.

Much remains to be done. To create the communication systems of the future, we must probe deeper still for new knowledge of Nature's laws. We must continue to develop new techniques in switching, transmission and instrumentation for every kind of information-bearing signal. As never before, communications offer an inspiring challenge to creative men.

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GEN. DAVID M. SHOUP

Commandant, United States Marine Corps

First To Fight

The United States Marine Corps still has its feet on the ground

THE exhilaration of racing our missiles with light itself into astronomical distances has put many of us into a frame of mind where we tend to look to the skies instead of at our all-important foot soldier. One of the oldest and most steadfast of these is the United States Marine, whose heroic exploits have been sung in all corners of our warring world.

Our hard-fighting aggregation of "Leathernecks" serves as a sound, realistic reminder that today's battles, such as the Korean conflict, are not won with nuclear weapons but that our survival is dependent on the man with the rifle.

The U. S. Marine Corps was established in 1775 by an act of the first Continental Congress. It consisted of only two battalions with a structure similar to that of the British marines, intended to aid in the defense of the colonies.

In every war that has involved the United States, the Marines have been there, ready to fight in hand-to-hand combat "from the halls of Montezuma to the shores of Tripoli." In the Spanish-American War the Corps consisted of 75 officers and 2,000 enlisted men. It then was increased to a total of 31,824. By 1928 the fighting strength of the Marines was 1,249 officers and 18,000 enlisted men. Today, the Marines number 156,000 enlisted men and 16,000 officers—a large drop since the Korean war.

The duties of the Corps, which is actually a component part of the United States Navy, are varied. Marines serve as detachments to guard and protect naval installations at home and abroad; they guard American legations in foreign countries; and they serve as landing forces to protect American lives, property, and interests in countries where disturbances arise. But their principal task which gives the Marine Corps the much-envied position of being "first to fight" is as the Fleet Expeditionary Force—the spearhead of almost every amphibious landing in which our armed forces participate.

Gen. David Monroe Shoup, now serving as the twenty-second Commandant of the United States Marine Corps, assumed his present duties and rank on January 1, 1960. He was born near Battle Ground, Ind., and attended school there. After being graduated from DePauw University in June 1926, he accepted a commission as a Marine Corps second lieutenant.

General Shoup's duty assignments in the 1920's and 1930's were typical of a young Marine officer of that era. He saw service in Philadelphia, Tientsin, Pensacola, San Diego, Quantico, Bremerton, Shanghai, and Peiping.

General Shoup earned the Nation's highest award, the Medal of Honor, while commanding the 2nd Marines and all Marine corps troops in the bloody assault against Japanese-held Tarawa in November 1943. He also received the Legion of Merit with the Combat "V" for his part in planning the Tarawa campaign and, at Rendova, earned the first of two Purple Hearts.

After this campaign he remained in the Pacific for nearly a year, taking part in the Saipan and Tinian campaigns and was again awarded the Legion of Merit with Combat "V." He returned to the United States in October 1944.

Following a number of assignments in the United States, General Shoup was promoted successively to one-, two-, and three-star rank and served tours as Fiscal Director of the Marine Corps, Inspector General, Commanding General, 1st Marine Division, and Commanding General, 3rd Marine Division.

While serving as Chief of Staff, Headquarters, Marine Corps, Washington, D. C., in August 1959, he was named by President Eisenhower to succeed Gen. Randolph McC. Pate as Commandant of the Marine Corps.

TO lead the force of tough, well-disciplined fighting men who comprise the Marine Corps, we need a man with "leadership, daring tactics, and selflesss devotion to duty." These are the very words applied to Gen. David Monroe Shoup, new U. S. Marine Corps Commandant, when he received the Congressional Medal of Honor. Known as a "Marine's Marine" by the men in his command, he is the twenty-second Commandant of the fighting Corps. He assumed his new duties on January 1st of this year.

General Shoup is a modest man, but his record speaks for his ability and daring. His basic approach to the challenge of command is "take charge, charge hard"—the same technique he applied at the memorable Battle of Tarawa in 1943. He hasn't changed much since that time, for the first working day after assuming his new duties as Commandant, General Shoup spelled out his "views, designs, and policies."

Dubbed "Shoup's manifesto," the document was hailed as a masterpiece of plain English. Conspicuously absent were federal jargon, elegant euphemisms, and fancy circumlocutions. Typical of the content of the manifesto were the remarks: "Our most important job is to get as much fight from our plight as we can," and "Battles are won by Marines with their feet on the ground."

The American Ordnance Association salutes the new Marine leader, offers its assistance, and recognizes the long and glorious history of one of our most colorful, brilliant, and hard-hitting fighting organizations—the United States Marine Corps.

Freedom of Action

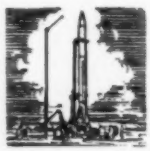
The American citizen wants some sign that the traditional qualities of originality, imagination, and resourcefulness are being applied to the production of our military weapons and to our national strategy

Maj. George Fielding Eliot

THE rising anxiety of many Americans about the state of the national security is instinctive rather than intellectual. The polemics of press and politicians about something called a "missile gap" help to confuse the thinking of the average citizen without in any way allaying his uneasiness.

He is not reassured by being told that we are safe from attack for one more fiscal year. He is disturbed by being exhorted, on the other hand, that we must hurry to catch up with Soviet missile production.

His mind tells him that being safe for one more year isn't quite good enough. His instinct tells him that running to catch up with the enemy in the production of the enemy's chosen weapon isn't the way to be safe in any year. He would heartily agree with Francis Walton's statement in the January-February 1960 issue of ORDNANCE ("Industry in the Cold War," p. 588) that we are too prone to "the vice of always following the leader and the attendant fate of always coming in second."



What he really wants is some sign that such supposedly American qualities as originality, imagination, and resourcefulness are being applied both to the production of military weapons and to a consistent long-range strategy designed to support and advance the Nation's purposes.

These anxieties, these questionings have their roots deep in the soil which has nurtured our country's growth.

Major Eliot is military analyst for the Mutual Broadcasting Company and naval correspondent with General Features Syndicate.

Throughout history, free societies have instinctively sought secure frontiers. In earlier times, this was in tacit recognition that political freedom for individuals was in some degree inconsistent with a continuous state of full military preparedness. It takes time to sound the tocsin and summon a citizen militia to arms; hence those peoples who cherished freedom and feared a standing army as the possible instrument of domestic tyranny sought natural barriers to secure them against surprise by a foreign foe.

This was the more necessary because, as a rule, the release of individual energies within a free society tended to generate such wealth as to make these societies well worth plundering.

Experience proved, however, that mere static defense might not be enough. It was not by chance that the Swiss developed the finest infantry in Europe and acquired the habit of carrying war to their Austrian and Burgundian enemies—with notable success.

Nor was it by chance that the English, after the lessons of the Spanish Armada and the Dutch wars of the following century, began the slow development of a standing army, so that the sword of amphibious mobility could become an effective means of maintaining the European balance of power by forestalling so great an aggrandizement of any continental state as to threaten the security of the island nation.

In both cases, within the limitations of circumstance, the principle of mobility was applied to provide an active defense rather than sitting still behind mountain or ocean ramparts and abandoning the initiative to the enemy.

THE reasons for this were both military and economic. To the need for a free people to be secure in their homes and workshops, so that their energies might be devoted to productive ends, was added a new requirement as industry became more versatile—the need for secure access to more distant sources of supply and more distant markets.

Our own American forebears were motivated by these familiar and proven considerations in their foreign and military policies. They desired to avoid the building up of a large regular army, but they were resolved to be secure against surprise attack.

Just as the English could not be at rest until they had secured the union of the crowns of England and Scotland, so that the latter could no longer menace them with a second front in their wars with the French or serve as a

bridgehead for invasion, so our ancestors—having won their independence from these same English by hard fighting—could not be at rest until they had denied the French a lodgment in Louisiana, expelled the Spaniards from Florida by a combination of violence and persuasion, and extended their frontiers to the Rio Grande and the Pacific Ocean.

The Monroe Doctrine—keystone of our foreign policy for the best part of a century—was essentially a device to prevent the accumulation in the Western Hemisphere of any concentration of European force strong enough to threaten us with sudden attack. A tacit understanding with Britain was the guaranty of this policy.

While control of the Mexican border and various Indian disturbances did compel the creation of a modest standing army, we followed the British pattern of developing that army in the constitutional tradition of supremacy of the civil over the military power. For the rest, we relied on distance and time.

Yet when the coming of the steamship cut down our reaction period, we began to stir uneasily; and when British sea dominance in the Atlantic was seriously challenged for the first time since Trafalgar by the rise of the German Navy, while a new sea threat (Japan) appeared in the Pacific outside the waters which the British fleet could be expected to control, the American people began for the first time in their history the systematic building, year by year, of a powerful Navy of their own.

Events were catching up with our comfortable security; we in our turn were shifting, as the Swiss and the British had done before us, to an active denfensive posture of widening scope. We, like they, foresaw that a foreign war might be forced upon us. We, like they, preferred to fight—if fight we must—on foreign soil rather than our own.

IN the two great wars of this century we did just that. Each time we began by hoping to avoid "involvement." Each time we found ourselves threatened by the accumulation of power in hands which were inherently hostile to our way of life. Our instinct warned us that we could not safely suffer such power to become supreme in Europe or in East Asia. It was just such an instinct that had drawn the British into war against Louis XIV and Revolutionary France.

In the wars of the twentieth century, when we realized that British intervention alone would not suffice, we took up arms to destroy the danger while it was still far distant from our homeland.

Each time, when military victory was won, we sat back and wondered why the fruits of victory—a season of peace and quiet—still eluded us. But a season of peace and quiet is still what we seek. If we can no longer have it by the establishment of secure frontiers on a planet where geographical frontiers no longer have the meaning they had for our founding fathers, we are nonetheless resolved to have peace and quiet on a global basis and on terms compatible with the further development among mankind of those free institutions which our ancestors defended.

The instinct to be secure against surprise, to avoid allowing the initiative to rest with the enemy, to shun passive defense and base our strategy on the principle of freedom of action so that we and not the enemy may choose the battlefield—that instinct is still with us today. Is it remarkable that a people with such a strategic instinct, born of such a national experience and such a heritage, is deeply troubled to find itself confronted by a determined foe and see its military freedom of action being gradually entombed in monstrous concrete missile sites located in its own heartland?

Let us remind ourselves again that we cannot expect the average citizen to be able to analyze all the reasons for his uneasiness. He simply knows instinctively that passive defense is dangerous —in the nuclear age, more immediately dangerous than ever before. He wants something better. He wants those American qualities of originality, imagination, and resourcefulness applied to this most urgent of all problems.

He knows very well that many individuals possessing such qualities in full measure are to be found among those who contribute to and help formulate our military policies and the production of our weapons. He knows such qualities exist among the senior officers of the armed services—they have been demonstrated in war within recent memory. He knows such qualities exist among the leaders of our arms industry—success in industrial competition is not to be had without them. He knows that political success requires such qualities in due measure, too.

BUT he looks in vain for a national strategy, a national armament policy, which reflects and is inspired by originality, imagination, and resourcefulness. Each year, as Gen. Maxwell D. Taylor has said, "our existing military programs are projected forward by one more budgetary increment, following the same direction given by budgetary actions of years before."

The citizen may not understand the details of this process, but he senses that the net effect, if continued, will freeze our military posture into an unchangeable pattern and paralyze our national freedom of action in future emergencies.

So our citizen cannot avoid the feeling that negative decisions and influences rather than affirmative decisions and influences are largely determining the guidelines of our military policy and our choice of weapons. This is what gives him the creeps—and it is easily understandable that it should do so.

For a society which has thrived and grown great on the energy output of individuals imbued with the competitive spirit can have little confidence in a military policy which is not only negative in purpose but is becoming statically defensive in its armament.

Our citizen sees a hostile leadership imbued with an affirmative purpose—the domination of the world. He sees it constructing armaments, conducting propaganda, pursuing economic policies all tailored to that end. He hears Khrushchev boasting day by day that the U.S.S.R. is the world's most formidable military power. He may or he may not quite believe this, but he can't escape the idea that a lot of people in various parts of the world do believe it.

Indeed, the military editor of *The New York Times,* Hanson W. Baldwin, reported in mid-February from Geneva: "There may be debate about the 'missile gap' in the United States, but there is little or no debate in Europe, where most persons seem to accept U. S. military inferiority as a fact."

Mr. Khrushchev himself appears to accept it as a fact, or at least he is only too happy to encourage others to do so. The American citizen can't avoid knowing this, nor can he avoid the knowledge that the Soviet leadership has a sense of direction, of mission, and of purpose to which every act of the Soviet Government is designed to contribute.

CAN we expect our citizen to believe that negative policies and static military defense can defeat determination and consistency of this quality?

He does not believe it. Because he does not believe it he is not content. And from his discontent, changes are coming of which the outlines are already taking perceptible form.

More than twenty-five centuries ago, the Greek strategist Xenophon wrote that the art of war, at bottom, is the art of keeping one's freedom of action. It is to this end that the Soviet Union today builds its giant missiles. The Soviet military purpose is to regain freedom of action, freedom from the constraint of "massive retaliation," either by destroying outright the instruments of massive retaliation or by confronting us with so formidable a counterthreat that we will not dare to invoke nuclear sanctions against them.

It was to this end that the swift-striking, far-reaching ICBM was designed; it is to this end that it is being produced and brandished in the plump hands of Mr. Khrushchev. It is the weapon of surprise *par excellence*—the chosen weapon of a government which must prevail by force or by terror if it is to prevail at all.

The present danger to the United States, and to the liberties of the free nations who depend on the protection of our power, lies in the possibility that the Soviet leadership may indeed regain its freedom of action—either by the actual disarming of the United States by the surprise destruction of our nuclear striking power or by the gradual erosion of the will of the American people to go on bearing the horrible strains of split-second confrontation.

Our troubled citizen, listening to the exultant Mr. K., wonders whether we are not doing exactly what Mr. K. most wants us to do by tying up more and more of our military resources in fixed and calculable armament. Is this not making the enemy a present of a mighty physical as well as psychological advantage?

Why, many Americans must be wondering, can we not confront Mr. K. with an American strategic concept, implemented by American tactical and logistic ideas and weapons to support them, that would make Mr. K. a little less sure of himself? Are the enemy's chosen weapons really those which are best suited to American needs, American geography, and American purposes?

These doubts, and the disquietude they engender, constitute a political fact of measurable dimensions—a fact which cannot much longer be ignored or appeased with half-answers and temporary soothing pills.

Something fundamental will have to be done, and the shape of it is already becoming apparent through the political fog. In essence it amounts to a return to the sound strategic concepts of earlier days, adapted to the widening scope of our present responsibilities and the shorter time limits of modern weaponry. In principle, it would confront a relatively immobile enemy with a combination of fire and movement which will immensely increase the risk factor in his future calculations.

Such a program would provide us as rapidly as possible with mobile deterrent forces, seaborne and airborne, that could not be knocked out by ballistic missiles in a surprise holocaust. It would also provide us with the relatively modest increases in our nonnuclear forces—land, sea and air—which would enable us, under the shield of our invulnerable deterrent power, to deal effectively with Communist threats of lesser dimensions wherever these might appear.

The twin purposes of such a policy would be (a) to preserve our own freedom of action, and (b) to continue to restrict the freedom of action of the Communist powers to use force for the accomplishment of their ends. If we are ever to have our season of peace and quiet, which we have sought in vain for so long and sacrificed so much to achieve, it will be by convincing the gentlemen in the Kremlin that they can never hope to become the masters of the world.

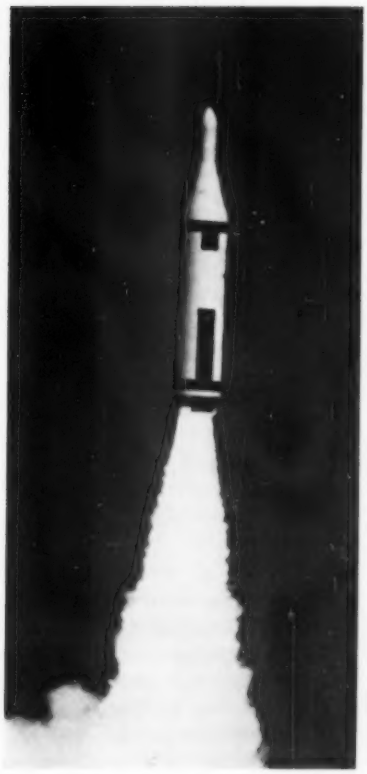
We must do more than that. We must convince the rest of the free world that American power can be relied on to protect them against Communist aggression, and so encourage them to contribute to their own defense as far as their means permit, knowing that they will not be left to fight alone and that timely help will be available.

IF we are to convince others that we will help them resist aggression, we must also display a self-respecting determination to protect our own legitimate interests throughout the world. One of the major reasons why we yearn for our season of peace and security is because our economic prosperity depends on freedom of movement, of goods, of capital, of enterprise throughout the free world.

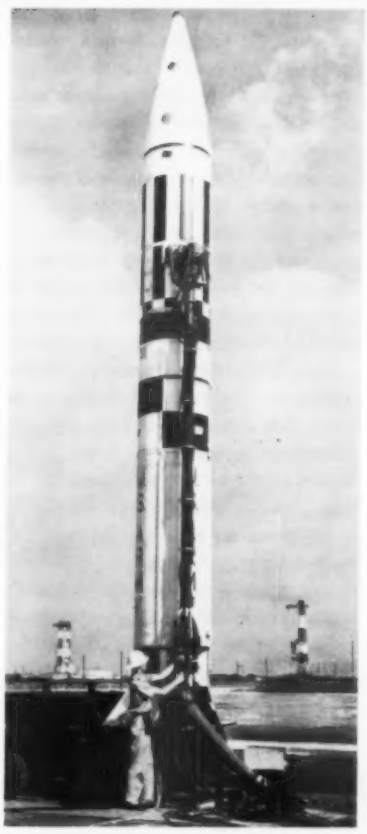
The expansion of American industrial and commercial ventures in other countries during the past few years has reached phenomenal proportions. It has become an integral and indispensable part of the vast system of production, distribution, and trade on which, in the last analysis, the livelihoods of hundreds of millions of free individuals depend or are coming to depend.

The hope of better living conditions is bound up with this system just as is the hope of more acceptable and efficient social institutions and government services. Democracy may not be an article of export, but free enterprise has to be. We have learned here at home, by bitter experience, that the price of free enterprise, like the price of political liberty, is eternal vigilance.

There can be small doubt that many of the obstructions and difficulties which American policy and American economic ventures (public and private)



Above, left, the Navy's Polaris; above, right, the Air Force Mace; right, below, the Army's new Pershing missile—all mobile defense weapons.



have encountered lately has been due to the rising impression that the balance of power is shifting toward the Soviet Union.

Instinct is as strong among other peoples as among our own; and the instinct of the weaker peoples is to choose the winning side in the conflicts of the mighty.

Thus what we do in the way of establishing an invulnerable deterrent force, what we do in the way of dealing firmly and promptly with local Communist aggressions, will help regain for us the respect of those who now think they see us slipping toward an inferior military status. Indeed, the very means which logic compels us to adopt for these purposes—that is, a wider deployment of mobile weapons systems and the forces required for their defense—will provide maximum global visibility for our military establishment.

It also will require us to adopt a principle which was axiomatic to the British in the nineteenth century—that the gates of the sea, those narrow waterways where land power can obstruct free maritime movement, cannot be left in hostile hands or in the hands of those who might subserve a hostile purpose.

This principle we likewise must apply to the unobstructed freedom of certain of the world's air lanes.

The hard fact is that the peace of the world, which we all hope one day will come to be the collective responsibility of all the citizens of the world through responsible global political institutions, must, while the Communist threat endures, be a *Pax Americana*.

The frontiers of that peace encompass the globe and are reaching out into the unknown darkness of interplanetary space. Like the wilderness frontiers of our pioneer ancestors, the hemispheric frontiers of a later day, and the sea frontiers of this century, these new frontiers can be made secure only by active defense—by power in motion: power generated by the energies of a restless and determined people.

We are told by some who despair of the Republic that the wellsprings of American energy are drying up, that we are sinking into slothfulness, absorbed in the pursuit of comfort, careless of our destinies. It was on that estimate of America that Ludendorff relied when he forced unrestricted submarine warfare on a reluctant German Government; it was on that estimate of America that Tojo counted when he assaulted Pearl Harbor; it was that estimate of America which Hitler accepted and broadcast to the world as the guarantee of the Reich of a Thousand Years.

Yet all these have perished, destroyed by the American power which they derided. The war lords of Communism will do well to pay attention to the lessons of history. For the discomfort of our citizens today is a sure indication that we shall not rest content with static defense, despite the incantations of the missile wizards. We shall demand weapons consistent with our instincts—weapons that shall assure us now and for the foreseeable future of the indispensable basis of national peace and security—freedom of action.

Nuclear Arms and Policy

Rather than keep millions of men under arms to contain the Red manpower Goliath, we chose to rest our security on the atomic slingshot which we had developed at great expense and effort

John F. Floberg

THE American Ordnance Association has always had as its reason for being an interest in and a devotion to the physical security of this country. The friendship of its members for each other and the great diversity of their commercial, industrial, and human interests always have impressed me as not obscuring but rather emphasizing the primacy of their patriotism as manifested by the uninhibited support which they have given this organization. The skilled leaders of the organization, both past and present, have been able to elicit the enthusiastic and unselfish efforts of great numbers of our fellow citizens in support of and assistance to the military services, as well as the basic American ideals of freedom and justice, for the protection of which those services exist.

It is with this orientation of the American Ordnance Association in mind that I wish to discuss a few of the aspects of the atom as the principal instrument of the country's physical security and to touch on some and leave to your imagination other effects which erosion of that instrument's availability would imply.

Section 1 of the Atomic Energy Act declares the policy of the United States with regard to atomic energy in two paragraphs:

"a. The development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security; and

"b. The development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise."

Mr. Floberg is a member of the U. S. Atomic Energy Commission. This article was taken from an address given by Mr. Floberg before a recent meeting of the Washington Post of the American Ordnance Association.

The Atomic Energy Commission, guided by these statements of national policy as established by the Congress, conducts both a diversified program in the peaceful use of the atom, paced to progress at the rate which technical developments permit, and a military program which profits from the advantage of several years' head start on the peaceful atom program as well as from a relative homogeneity of purpose and simple clarity of goal.

I have, like others on the Commission, frequently discussed in public the Commission's peaceful atom program. It still surprises me that relatively few of our citizens fully realize that the first managed nuclear reaction was in an instrument of peace—the nuclear reactor under the stands of Stagg Field, Chicago, in December of 1942—and it seems to me that that event put a stamp upon the atom that marked its ultimate employment for human welfare as its inherently most appropriate application.

I fear that sometimes the already-achieved status of the atom in its ability to combat pain and disease through both its diagnostic and its therapeutic medical application, its ability to curtail hunger through agricultural applications, its ability to raise the material standard of living through industrial applications, and even its developing capability for generating power, are inadequately appreciated.

TEMPTED as I am to expand further on these peaceful and most attractive applications of nuclear energy, I am, however, going to discuss the atom's "paramount objective of making the maximum contribution to the common defense and security." In order to lay a foundation for current problems in that area, I would like to review briefly a little history.

The military atomic age was initiated in July 1945 with the explosion at Alamogordo in New Mexico. Within days thereafter one nuclear weapon destroyed 4.7 square miles of Hiroshima and 1.8 square miles of Nagasaki.

From immediately after the cessation of hostilities between the Allies and

the Axis until 1947, the United States went through a "demobilization period." The problem of the atom was a difficult and important one during this period, and President Truman, in a message to Congress in October 1945 urging legislation for the development of atomic energy, keynoted the feeling which pervaded those years: "The War Department has taken the initiative in proposing that it be divested of the great authority that goes with the control of atomic energy, because it recognizes that the problems we now face go far beyond the military sphere."

A few months thereafter, on August 1, 1946, Congress enacted the original Atomic Energy Act, establishing the Atomic Energy Commission and clearly adopting the principle of civilian control over this newly available source of energy. One other significant event marked this chapter in the history of atomic energy, and that was that the U.S.S.R. refused to accept the United States plan of June 1946 for control of the atom, known as the "Baruch Plan," because it called for an inspection system—a prophetic difficulty.

BETWEEN the years 1947 and 1950, we discovered that in our preoccupation with converting our wartime military strength to a strict peacetime economy, our national policy had amazingly failed to take adequate account of the fact that the Soviet Union was not very subtly posing a threat to the long-range security of all freedom-loving peoples.

A series of unfriendly incidents, to use a euphemism, on the part of the Soviet Union in Iran, the Balkan countries, Turkey, Greece, and within the operating procedures of the United Nations, awoke the Nation, however, and convinced the last optimists that the Soviets were determined to destroy any surviving semblance of wartime friendship and cooperation.

These disillusioning experiences with the Soviet Union, together with her complete rejection of the Baruch Plan for the international control of atomic energy, clearly indicated, if all of that proof was needed, the Soviet Union's suspicion of the Western Powers, her contempt for them, and her intention not to cooperate with them in search for permanent peace.

The factor which made perfectly clear the termination of any security enjoyed by the free world as a by-product of an American monopoly of the atomic bomb was the announcement on September 23, 1949, that the Soviet Union had exploded an atomic device. From this moment on the Western world knew that whatever security had been inferred from an American monopoly of that weapon now had to be sought in military and political policies both more fundamental and more complex than reliance on any single weapon.

The formidable task of preventing free countries from successively being subjugated to Soviet aggression obviously seemed appropriate for sharing by all the nations of the world desirous of protecting their own freedom. The policy of "collective security" became a reality as the Truman Doctrine in 1948, and it was bolstered by the Economic Cooperation Act of 1948 and the signing of the North Atlantic Treaty, our first peacetime military alliance with Europe, in 1949.

The strategic concept for the defense of NATO territory and a military plan for carrying out this concept evolved. The United States arsenal of nuclear weapons could not help but influence the basic success which the organization has enjoyed, as attested by the ultimate fact that in its part of the world no further losses to Communism have been suffered.

In the meanwhile our own military system was undergoing the reorganization called for by the National Security Act of 1947 and its comprehensive 1949 amendments. Although only the Air Force had a capability at that time of delivering atomic bombs, and then only in the discharge of its mission of strategic air warfare, both the Army and the Navy, as well as various other interested parts of the Air Force, evidenced an interest in applying this newly available source of energy to their tactical weapons systems. The Department of Defense then placed requirements on the Commission to improve strategic bomb design and to provide tactical weapons.

The Korean war in 1950 presented a new kind of problem to our policy of containing Communism by extending material and technological help to free nations. We amended the policy to include containment through limited war, a refinement which gave our field commanders specific military obligations but curtailed them from utilizing their full military potential for fear of turning local actions into global war.

The beneficial contribution of the Korean war lay in the fact that it alerted the free world into mobilizing against future aggressive actions by the Communists since the latter had evidenced that extended military operations were included within their choice of weapons.

It was during this period that President Truman directed the Commission to continue to work on all forms of nuclear weapons, including the thermonuclear bomb. The Commission responded to Defense requirements for a more diversified stockpile by stepping up its development program and for additional quantities of weapons by increasing its production capacity.

The net effect was the addition of limited tactical capabilities and new strategic capabilities to the inventories of the various military services. It was also during this general period that weapon developments took a new turn with the establishment of Defense requirements for the development of warheads for certain missiles which the services expected to obtain in the future.

IN 1953 there was a change of Administration, and the United States undertook a reevaluation of her defense policy. The net effect of the reevaluation was a continuation of what General Marshall had described some years previously:

"Our supreme policy has been to curb Communist aggression and, if possible, to avoid another world war in doing so. The execution of this policy has required extraordinary patience, firmness, and determination in meeting and helping our allies to meet chal-

lenges in Iran, Greece, Turkey, Trieste, Berlin, and Indochina, and finally Korea . . . It is, therefore, our policy to contain Communist aggression in different fashions in different areas without resorting to total war, if that be possible to avoid."

As we continued the reevaluation of our defense posture in the years after World War II, it became clear that "massive retaliation," although traveling by various aliases, had in reality been one of our major defensive weapons since Alamogordo. It was equally clear that the progressive encroachment of Communism on the free countries of the world, coupled with our own desires to economize our defense expenditures, had necessitated our policy of relying heavily on the retaliatory powers of our arsenal for the containment of aggression.

The policy received a new dimension when we fired our first thermonuclear device in the fall of 1952 and thereby demonstrated that a stockpile of nuclear weapons could contain instruments of massive destructive power. Subsequent explosions made clear that the United States was developing weapons of large scale, and a series of development tests in Nevada showed that we were rapidly obtaining a versatility in the use of nuclear weapons for many purposes.

These tests were laying a solid foundation for a national capability of limiting wars to the minimum force necessary to deter and repel aggression, a capability to confine damage in high degree to the battlefield and minimize the consequential and undesirable products of the employment of the large weapons.

THIS historical review should indicate that the evolution of our defense policy since World War II was based on the fact that our nuclear capability has been the pivotal force influencing our current concepts of security. Whether it has been the keystone or only the alleged keystone of our national security in those years, it certainly has influenced the thinking and attitudes of those responsible for our defense as has nothing else in that period.

The Army, Navy, Air Force, and Marine Corps all have revised their strategy and tactics, offensive and defensive, essentially in parallel with the development of nuclear weapons.

One additional important fact relative to free-world security is the present area of exchange of nuclear information with our allies. Although creation of our initial nuclear capability was the result of a massive international effort, the Atomic Energy Act of 1946 originally treated the atomic weapon as a device that had to be restricted to the United States.

The United Kingdom had no choice but to develop an atomic capability independently, and it did so; and it now appears that France will demonstrate

that its efforts along the same line have not been entirely without success.

Suffice it to say of this important subject that the Atomic Energy Act has evolved so as to permit more or less detailed cooperation with our allies in various areas of the military atom, and specifically with NATO and NATO countries, with regard to (1) the development of defense plans; (2) the training of personnel in employment of and defense against nuclear weapons; and (3) the evaluation of the capabilities of potential enemies in the employment of nuclear weapons.

I have sketched this history at some length because it is against this background, illustrating definitively how our nuclear capability has been the slingshot in David's hand as we have faced the manpower Goliath, that we pose one of the critical security issues of our lifetimes. We who chose to build our military strength around the atom could physically have made the opposite choice of keeping millions of men under arms on the same scale as the Soviets, but the forfeiture of both freedom and resources that a slave nation will accept is unthinkable in a free society.

"We must continue our efforts to reach agreement with the Soviets on disarmament . . . but once again, it must be an agreement that can be policed."

Instead, we chose to follow our traditional way of life and to rest our security on technological resources which we had developed at great expense and by great effort. In doing so we expanded our slingshot's capability from mass retaliation to an integral element of tactical as well as strategic forces—land, sea, and air.

Now for a year and a quarter we have voluntarily chosen to suspend any further evolution of our slingshot or even any further testing of it—and for a noble cause. For the purpose of lessening international tensions and because cessation of nuclear tests, in spite of its not very great substantive value, might have a symbolism that would make it an initial step toward disarmament measures of real substance, the President announced in August 1958 that this country would suspend nuclear tests as of the following October 31st and undertake the negotation of a permanent, comprehensive, and fully policed suspension of nuclear weapons tests.

SINCE October 31, 1958, neither we nor our British friends have fired any nuclear explosions, and except for a few which the Soviets fired in the first days thereafter for the apparent purpose of defiance, they have fired none of which we have knowledge. And since that date we have been negotiating in Geneva for the purpose of reaching the agreement which has been our goal.

For what purpose, however, have the Soviets been negotiating? As nearly as I can tell, for the purpose of having us suspend all nuclear tests while they may or may not be suspending all of theirs. Not only their reluctance to negotiate sincerely with regard to underground tests but the truculence with which they have refused cannot help but inspire suspicion.

The peculiar aspect of the Soviet attitude is that last spring Khrushchev wrote to the President as follows:

"It is my opinion that, on the basis of the proposals made by you and by us, we are quite able to find a solution to the problem of discontinuing tests that

would satisfy both the interests of the powers having nuclear weapons and the interests of all other countries, *and to establish such controls as would guarantee strict observance of the treaty*" (emphasis supplied).

What has happened to the principle that there must be controls that would guarantee strict observance of the treaty? Recently Khrushchev said to the Supreme Soviet, according to *The New York Times* account of his speech:

"SUPPOSING modern techniques are not absolutely foolproof in detecting underground nuclear blasts; supposing it is sometimes difficult to distinguish underground nuclear explosions from earthquakes, from explosions of a volcanic nature. But if a proper agreement is signed it must, of course, be honestly carried out by all sides. . . .But even if today we do not have guarantees that all explosions will be recorded accurately and completely, the conclusion of an agreement to end tests would place great responsibility on the parties to it. And it goes without saying that they will have to abide strictly by it. If some side violates the assumed commitments, the initiators of this violation will cover themselves with shame; they will be branded by all the peoples of the world."

Apparently the guarantee of strict observance has in the course of a few months deteriorated into whether the Soviets might feel more ashamed of themselves for violating a test-suspension treaty than for their conduct at Budapest. Apparently the prospect of being branded by the peoples of the world for violation of this commitment would be more of a deterrent than being branded by the United Nations for the Hungarian tragedy. Apparently it goes without saying that the parties to an agreement to suspend tests will have to abide strictly by it and that it must of course be honestly carried out by all sides—even though in the same speech the agreement on the status of Berlin curiously becomes a threat to peace. Apparently observance of this agreement would somehow be more compulsory than observance of the agreements made during World War II, at Potsdam, and at the last Summit Conference at Geneva. Apparently the guarantee of strict observance boils down to the Soviet reputation for truth and veracity.

"The beneficial contribution of the Korean war lay in the fact that it alerted the free world into mobilizing against future aggressive actions by the Communists . . ."

Although the President has made it clear several times and Khrushchev agreed that the suspension of nuclear tests must be completely policed, what happened to a group of distinguished American scientists who went to Geneva to discuss with their Soviet opposite members the latest scientific information on the subject of underground nuclear explosions?

The Soviet representatives, wearing the guise of scientists but obviously just going through the motions in the spirit of a formality which had to be endured in order to make a record, furnished not a scintilla of a scientific information but instead satisfied themselves with a tirade against the men whom the United States had selected for their scientific distinction and their specialized expertness in the subjects to be discussed.

In the Soviet Annex to the technical report they accused our representatives of "misrepresentation," of having "repeatedly modified the primary data," of "perturbation," of "manipulations of the primary data," of being "on the brink of absurdity," and otherwise abused them. And then, in spite of having made no contribution to the scientific discussions, they had the incredible nerve simultaneously to suggest that "It is clear from this that the next task is . . . to conclude an early agreement on the cessation of tests, establish a control system, and improve it on the basis of practical experience."

After this demonstration of their contempt for the latest scientific information on the subject, did they really think we would be no naïve as to place our total reliance on their future objective evaluation of other scientific data? Forcing science to conform with political theory is no novelty to the Soviets, but when they insist on the propriety of technical criteria which would classify as an earthquake a 19-kiloton explosion which we fired and concerning which we know the facts, can one depend on trust?

We must continue our efforts to reach agreement with the Soviets on disarmament as well as on all other issues that divide us, but once again it must be an agreement that can be policed. We made the mistake between the World Wars and again in the late 1940's of disarming on the unaudited representation that other countries were doing likewise, and we must have learned that our reliance must be on inspection rather than trust in this vital area. All steps toward disarmament, including the cessation of nuclear tests, must be similarly foolproof.

IF any step toward monitored disarmament succeeds, we must immediately press for the next step, not pressured by some hysterical propaganda about banning nuclear weapons (if I were Goliath I, too, would want David to agree to rely exclusively on bare fists and to ban slingshots) but rather in the light of sound scientific facts.

Political recrimination and personal vilification such as occurred in Geneva can only retard progress toward the peaceful goal all sensible people seek. The subject is too important to be treated like a propaganda football, and the Soviets should know by now that Americans do not scare easily enough to be impressed by the muttering of threats and by chest pounding before the Supreme Soviet.

There is no need for us to tell either ourselves or anybody else in the world that our country is strong. In view of the intentions, both professed and demonstrated, of others toward the free world, let us make crystal clear, once and for all, that any reduction in our strength will be on an ironclad basis rather than under circumstances that could lead to the grand tragedy either of making us bait for the predator or of reducing our capability to help our free friends.

Antisubmarine Defense

U.S.S. Cobbler (Navy photo).

Navy task forces coordinate planes, ships, and subs to protect America

Vice Adm. J. S. Thach

THE North American continent is an island, and oceans separate us from nine-tenths of the world's population. Arcing out from the United States are sea lanes to every corner of the globe, carrying ninety-nine per cent of our total overseas tonnage. These are the sinews of our free-world alliances. Without them, our allies could not survive. Without them, our own survival is questionable.

Hitler's naval commanders knew this. The instant World War II exploded, his U-boats struck with devastating effect, again and again. Only incredible sacrifice and the law of averages saved our crippled supply lanes. Trading thousands of lives and millions of tons of critical merchant shipping for time, we frantically assembled antisubmarine forces until, by 1945, we were able to kill his U-boats faster than he could build them.

The lessons of World War II were not lost on the Communists. Scarcely was the ink dry on the peace treaties before they launched a massive submarine building program. Before most Americans were aware of their duplicity, they had begun to assemble an undersea armada which today numbers more submarines than all the other navies of the world combined.

Hitler started his war with about sixty U-boats. The Soviet Union already has more than seven times that number, and is still building. A majority of these are first-rate vessels. They are new. They are big. They are fast. They go deep and can stay down longer than the U-boat commanders of 1942 would have thought possible. The now famous "snorkel," perfected by German scientists too late to salvage victory in the Battle of the Atlantic, is standard equipment on Russia's modern boats, allowing them to breathe underwater with only the tip end of a stovepipe exposed.

Our NAUTILUS is the forerunner of the future submarine. Before long, standard Soviet equipment will include nuclear power and even deprive us of an occasional glimpse of the stovepipe.

Armed only with conventional mines and torpedoes, such a wolf pack could go far toward isolating us tomorrow. The Communists have demonstrated that they are not unaware of the potentialities of modern rocketry. Today, compounding the submarine threat to our island continent, a new weapon is available—the submarine-launched guided missile.

NOT a single square inch of the United States is more than 1,500 miles (medium range for a ballistic missile) from submarineable water; most of our population sits at point-blank range. This is why scientific research in the "liquid space" of the oceans is so important and why the United States Navy is devoting major efforts in this field.

The nature of the oceans makes that a tough job. Most of us think of the ocean simply as our highway for billions of tons of commerce. It is the ancient buffer zone that has insulated us from the quarrels of Europe and Asia for centuries. It is assumed that down

below are nothing but dark, silent, empty ocean depths. They are dark, all right, but if you think for a minute the depths of the seas are empty or silent, any antisubmarine sailor can tell you you are in for a big surprise.

Unfortunately, the quarry has much in his favor. He can hide in any corner of the trackless oceans, hundreds of feet below the surface. Locating him is not even as simple as finding a needle in a haystack. The haystack itself is our enemy.

Hidden beneath the surface of the oceans lies a murky morass of discontinuities difficult for the casual observer to appreciate. Populating it is a confusing family of flora and fauna ranging from microscopic organisms to giant whales. Most incredible of all is the noise racketing around through the undersea jungle: snapping shrimp, booming drumfish, moaning whales, and dozens of others, all sounding like submarines.

Gouged into the ocean floor are canyons miles deep. Mountain peaks surpassing the Rockies rise to within fathoms of the surface. Craters and ridges wrinkle and distort the ocean bottom. Sea water itself attenuates sound severely, blunting our primary means of detection.

This is the submarine's medium, a veritable jungle of which we know woefully little. Uncharted pinnacles from the ocean floor block our sonars, and can look, act, and sound like submarines when conditions are bad. Uncharted anomalies in the earth's magnetic field cry "wolf" to our magnetic detection equipment.

VARIATIONS in sea-water temperature, salinity, and density bend and deflect our sonar beams. A sharp temperature gradient, called a "layer," bounces back our sonar transmission as effectively as a tin roof. Weird underwater sound ducts caused by these same temperature discontinuities can echo a merchant freighter miles away, and mask a submarine under our very noses.

While we can measure and compensate to some extent for these variations in a given area, an hour later or a mile away, they may be entirely different. These phenomena are the submarine's best friends. We have not yet learned enough of the oceans to turn them to our advantage.

To one schooled in the notion of "silent, empty ocean depths" the incessant noise emanating from the inhabitants of the teeming undersea jungle is incredible. The dozens of chattering undersea creatures seem to conspire not only to sound like submarines but to act like them. Little fish form schools to deceive us; giant whales don't have to. Both have been known to behave more like a submarine than a submarine.

The Navy must be able to keep close tabs on millions of square miles of ocean. Not only must it know precisely where every unfriendly submarine is, and what he is doing at any hour of the day or night—it must also make sure that the enemy knows the Navy knows where he is and what he is doing. Even more important, he must know that the Navy is able to counter instantly any hostile move he makes.

Americans have shown great faith in the Big Bomb. The U. S. Navy does have an atomic antisubmarine bomb which it can use under certain circumstances, but this is certainly not the whole answer to the problem. In the first place we can't just vaporize a submarine going about his business on the high seas because we suspect that he may be able to harm the United States. International freedom of the seas is one of our most fundamental policies. Right up to the instant a hostile submarine starts shooting, the high seas belong to him just as much as any one else.

What is more to the point—he cannot even be scared with an atomic bomb if he cannot be found. It certainly won't slow him down much if our forces think they have him zeroed in and demolish only a whale.

Here, then, are two of the most serious problems in antisubmarine warfare: initial detection and identification. These problems, added to accurate localization and the ultimate ability to destroy a submarine if necessary, create a formidable task.

Keenly aware of the ever-increasing complexity of the modern submarine threat, the Commander in Chief of the Atlantic Fleet, at the direction of the Chief of Naval Operations, has organized three special task groups to accelerate the Navy's program by finding ways and means of combating this threat at sea. These groups are Antisubmarine Defense Groups Alfa, Bravo, and Charlie. Each has the common objective of improving the state of Antisubmarine warfare readiness. However, their specific objectives differ slightly: Alfa concerns itself with an across-the-board development of antisubmarine warfare tactics, doctrine, and operating procedures; Bravo concentrates on improved antisubmarine carrier group operations; and Charlie specializes in improved convoy escort operations.

THE first of these groups to be established was Task Group Alfa which came into being in April 1958. The efforts and progress of this task group are typical of the Navy's approach to operational aspects of the antisubmarine-warfare problem.

The hub of Task Group Alfa is the U.S.S. RANDOLPH which serves as a mobile command and communication center, a fast-moving air base, and a logistic depot. Embarked in the RANDOLPH is a squadron of twin-engined Grumman S2F Tracker aircraft (Carrier Antisubmarine Squadron 36), a helicopter squadron equipped with Sikorsky HSS-1 helicopters (Helicopter Squadron 7), and a detachment of four single-engined AD5W's.

Operating from ashore are P2V Neptune aircraft attached to Patrol Squadron 8. These provide long-range air patrols. A destroyer squadron (Desron 28) provides the staying power of surface attack units. Task Group Alfa also operates two antisubmarine sub-

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Admiral Thach is former Commander, Hunter Killer Force, U. S. Atlantic Fleet; Commander, Carrier Division, Sixteen; and Commander, Antisubmarine Defense Group Alfa. He is currently serving as Commander, Antisubmarine Defense Force, Pacific Fleet.

marines, the U.S.S. COBBLER (see photo on page 862) and CUBERA.

This group differs from the usual antisubmarine group in several ways. It has a greater variety of units; its units are kept together on a semipermanent basis; and it devotes its efforts exclusively to antisubmarine warfare.

For reasons of economy and operational flexibility the Navy for many years was reluctant to specialize its forces and concentrate all efforts on a single problem as is done in Task Group Alfa, but the gravity of the antisubmarine-warfare problem dictated unusual measures. These measures have paid off. The singleness of mission and relative permanency of forces enjoyed by Task Group Alfa have proved to be substantial factors in achieving progress. They have permitted the group to concentrate the effort and attention required to depart from established doctrine and to project concepts into the future.

The official objective of Task Group Alfa is "to accelerate the development of antisubmarine-warfare tactics, doctrine, and equipment in order to improve antisubmarine-warfare readiness."

This objective was too broad to permit direct translation into operations. It was therefore broken down into three major missions—team development, tactical development, and equipment improvement.

INITIAL efforts in team development were concentrated on bringing assigned forces up to a high level of individual competence. In addition to basic and intertype training it was necessary to determine the best utilization of the augmented units, the patrol aircraft, the antisubmarine submarines, and the AD5W aircraft. Permanent assignment of these units made it possible to integrate them thoroughly with units of the standard antisubmarine carrier group and to weld the whole into an enthusiastic, highly coordinated team.

Task Group Alfa also has investigated the capabilities of the nuclear submarine and the antisubmarine-warfare airship. The nuclear submarine has been found to have great potential for antisubmarine warfare, and the antisubmarine airship also appears to have potential but probably for more specific application in special situations.

When the task group goes to sea the U.S.S. RANDOLPH becomes the approximate center of an operating area one hundred miles on a side, known affectionately as "Alfa U." This area is divided by two diagonals into four areas known informally as the North, East, South, and West "classrooms." Instead of being satisfied with one set of operations at a time, the task group conducts four different types of exercises simultaneously, one in each of these "classrooms."

On any given day the northern classroom may contain destroyers and carrier-based aircraft exercising in coordinated operations. In the east, destroyers, helicopters, and a target submarine may be working on coordinated hold-down tactics. In the southern area, carrier-based aircraft may be assigned to practice intersquadron localization tactics. In the western sector, coordination exercises may be conducted, utilizing a patrol plane and an antisubmarine. Each of these exercises is going on simultaneously and for varying lengths of time.

At frequent intervals the entire task group is joined together for extended full-scale exercises such as a 24-hour hold-down or a 12- to 24-hour opposed transit during which all forces are employed in a coordinated effort. The length of the exercises is varied in order to bring more units, equipment operators, and supervisory personnel into play.

Antisubmarine warfare is a 24-hour-a-day, 7-day-week job. Each unit must be able to function as effectively at midnight as at noon. To accomplish this, Task Group Alfa has concentrated on the "3-team concept."

The commanding officer of any unit is, of course, incapable of actually supervising and controlling the operations of his unit continuously and must have trained personnel to carry on when he is of necessity required to rest. The 3-team concept has been successful in creating a group that has not only skill but staying power. Task Group Alfa can operate continuously at "full bore" when necessary.

The objective has been to train all units to work together. Although each unit has some capability that no other unit possesses, there are no individual stars on the team. It has been found that only under the most favorable conditions can any one unit by itself detect, classify, localize, and kill the target. Therefore, Task Group Alfa has had to learn to use the strength of one unit to compensate for the weakness of the other.

Alfa's basic objective, however, is tactical development. Specific details on the accomplishment of Task Group Alfa in this area cannot be given for obvious reasons. In general, it is a matter of getting the most that can be gotten from the tools available. Just as in fighter-plane tactics, quick reaction assumes prime importance in ASW—

An HSS-1 helicopter on antisubmarine duty takes off from carrier (Navy photo).

getting the right forces to the right place at the right time.

By spreading out, by closing in properly at the right time, and by using the right weapon, the group has developed the ability to find and hold a submarine with the equipment it has.

This requires the most complex tactics of all warfare. It involves three dimensions—hunting from the air, from the surface, and from below the surface. Against one submarine five vehicles are used—long-range patrol planes, carrier-based search planes, helicopters, surface ships, and submarines.

For example, a visual contact is made by aircraft—perhaps one of the Neptunes of VP-8. The pilot reports the sighting and commences tactics which include the use of sonobuoys and magnetic anomaly detection (MAD). Promptly, carrier-based S2F Trackers are launched for the area, helicopters are sent in to get their dipping sonar gear into the water, and destroyers are dispatched to help strengthen the contact.

THE P2V can get to the contact fast, and this is important. The slower S2F has detection advantages over the P2V because it can fly lower and make tighter turns. The helicopter has the advantage of hovering and lowering a sonar ball, and it can move rather quickly to shift search areas.

Yet the contact is never really solid until the destroyer arrives on the scene with its superior sonar and staying power. The submarine's advantage as a hunter derives from the fact that the pursuer is on equal footing with the pursued.

The best way that the effectiveness of the coordinated attack can be explained is to compare the units of Task Group Alfa to five slices of a pie. Assume that each unit has an inherent value of one. Working singly, the five arms of the group would have a total value of five. But when the best of each are fused together, and the gaps of one are filled with the strengths of another by juggling the slices of the pie, a capability is achieved that is no longer an arithmetical total. This total is considerably greater than the sum of the parts.

Task Group Alfa's flexibility has been developed to the point of tailoring tactics to fit environmental conditions. This has generated a strong interest and effort to learn more about these conditions and ways in which they can be exploited. There is a need for greatly increased basic oceanographic research. This not only can bring gains in antisubmarine warfare capability but also will bring long-range economic gains as we learn to exploit the manifold resources of our millions of square miles of ocean.

Task Group Alfa has made every effort to obtain the best available equipment for it's various vehicles. In many cases existing types of equipment had to be modified in order to fit them for ASW needs. An example which can be cited is the adaptation of a photographic flare pod, originally designed for jet reconnaissance aircraft, for use in the Tracker and Neptune ASW aircraft.

More critical are those needs which Task Group Alfa cannot meet by means of hard work and ingenuity. Ten needs for antisubmarine defense are:

1. Burglar alarms—warning systems that will indicate the presence and locations of submarines in deep ocean areas, in the moving areas around convoys or task forces, and in special areas not covered by the other systems.

2. Identification systems that will ensure that when our warning system flashes it has been triggered by an enemy submarine, that there is in fact a burglar and not a stray cat (fish).

3. A prediction system, similar to existing weather-prediction systems, for forecasting sound-propagation conditions at and below the surface over wide areas.

4. Central stations and prowl squads, mobile ASW forces, to ensure apprehension of submarines located by the warning systems.

5. Certain detection of any submarine which exposes any part of itself above the surface.

6. Provision in each ASW vehicle for the capability of finding, recognizing, and destroying submarines.

7. Discovery and utilization of phenomena, other than sound, for location of submerged submarines.

8. Weapons with range and accuracy equal to the detection ability of our equipments, so that a submarine found can be a submarine destroyed.

9. Forces sufficient to accomplish the mission. An increase in the capability of our vehicles and equipment will result in proportional decrease in the forces required.

10. Programs to meet these requirements should be established along two parallel lines: an interim program to improve present equipments to counter the immediate threat, and a long-range program of research and development to counter the future threat.

FULFILLING these needs will not be easy. Each represents a complex of difficult interlocking problems. The solutions will depend on many things, and the most important of these is the understanding and support of the American people.

ASW planes line up on flight deck of U.S.S. RANDOLPH (Navy photo).

The Government of Space

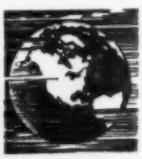
The American ideal of universal peace through freedom under world law should now be extended to let mankind recover a measure of control over human destiny as it progresses into the realm of space

Eugene E. Wilson

UNDER the vigorous leadership of the American Bar Association during the past year, its primary goal of world peace through world law has moved appreciably nearer to attainment. According to a public opinion poll of the association's members, three quarters of them endorsed the objective while a majority considered it attainable.

The reasonableness of this conviction became apparent at a space-law forum conducted in Detroit on March 12, 1959, when one panel member outlined a course of action through which government in space might be attained through the United Nations.

This space-law forum brought together representatives of the Michigan Bar, the American Rocket Society, and the Institute of Aeronautical Sciences. As the logical first step in their discussion of the legal aspects of space exploration, panel members undertook to demolish language and other barriers to understanding by defining the terms of their several specialities and stressing their primary functions.



For example, a rocket was defined as a space vehicle capable of transport without dependence upon aerodynamic forces. A satellite was defined as a body in orbit which conforms to the laws governing planetary action without dependence upon external or internal forces. By drawing these distinctions between aircraft and space craft the definitions clarified some of the principles underlying government in space.

Mr. Wilson is former president of United Aircraft Corporation, East Hartford, Conn., and a pioneer leader in the aircraft industry of the United States. He is a graduate of the United States Naval Academy, Class of 1908, and author of the recently published book, "Kitty Hawk to Sputnik to Polaris."

For example, the definition of space vehicles excluded aircraft, including high-altitude vehicles circling a planet under low power, from the category of space vehicles. Similarly, since international civil aviation conventions now in force are confined to aircraft, space vehicles such as rockets, missiles, and satellites were held to be excluded from such conventions.

This functional approach served to point up the extent to which technological capabilities had outrun the existing system of international law without the fact having gained public recognition. Indeed, just previous to the forum the East Berlin radio had protested the launching into earthly orbit of the American space vehicle, Discoverer I, without prior consent of the countries over whose territories it must pass.

Yet, while the term "air space" had never been defined, international civil aviation conventions do not apply to space devoid of air.

This raised the question as to just who should control space vehicles. Should control be vested in the national state subjacent to the craft's flight path at some prescribed instant? If not, should it reside in the state of the craft's nationality or flag in analogy with the law governing ships on the high seas? If neither, should such jurisdiction be vested in an international space authority?

The opinion was offered by a legal member of the panel that only a minority of experts of his profession would favor projecting territorial sovereignty outward into space. Since few if any states were capable of exercising coercive power in that medium, such extension would prove unworkable.

IT was stated further that most writers held the opinion that some sort of altitude boundary should be imposed on the air space wherein international civil aviation conventions would apply. Above this boundary, all space should be considered free to the use of all.

It was recalled to mind that the rule of sovereignty in the air space had been adopted for the purpose of protecting land, property, and persons situated upon the territorial domain of the signatory powers from harm or injury by falling opjects.

However, true satellites do not constitute a drop hazard in the sense of a

conventionally elevated object, and the same applies with even greater force to craft traveling at escape velocities. Hence the right to protect itself presently guaranteed a state by Article 51 of the U.N. Charter should continue to apply to aircraft but should not be extended to space vehicles.

Accordingly, it was argued, all craft engaged in orbital or superorbital trajectories must be exempt from jurisdiction by sovereign national states regardless of altitude. Indeed, the notion of altitude as a jurisdictional determinant should be abandoned in favor of trajectory.

TRAJECTORY is a precise mathematical function which describes and predicts the behavior of craft over an interval of time. It constitutes an ideal regulatory yardstick. Accordingly, international civil aviation conventions should be amended so as to become inapplicable to craft which, irrespective of functional definition and distance from the earth, describe orbital, escape, and interplanetary approach trajectories.

In other words, a proposal was advanced for classifying space vehicles not by where they might be located but by what they might be doing.

Moreover, it was declared to be not enough merely to exempt craft engaging in the above trajectories from the jurisdiction of subjacent states. If the policing of offending vehicles were to be left to individual states, chaos must result. Cosmic warfare might well be precipitated by recognition of national claims to jurisdiction over nonterritorial bodies which, under the law of nations, might be predicated upon discovery or occupation by state expeditions.

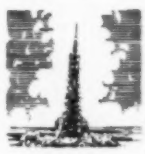
Accordingly, it was proposed that all craft while describing either of the three trajectories, orbital, escape, or interplanetary approach, be subjected to the exclusive jurisdiction of an international space authority in whose flag and agency they should be deemed invested.

Such an authority, it was believed, would assert its jurisdiction through a global detection, tracking, and policing network possessing a summary capability. In light of the accelerating progress in the art of ballistic missile warning systems and antimissile defenses, it was predicted that such a network could become operational by the time manned space-platforms and interplanetary expeditions become a reality.

It was anticipated that the international space authority would adopt a code which would cover problems of licensing satellite orbits, setting up operating standards for material, equipment, training qualification and proficiency, identification signals, allocation of signal carrier frequencies, and so forth.

Ultimately the code would cover crimes and criminal procedures as well as the redress of civil wrongs aboard space craft and nonterrestial bodies, but such details could be taken up concurrently with technical progress.

The proposed rule for exemption of orbital and superorbital craft from control by subjacent states was thought to provide a convenient bridge between those who might object to any sacrifice of national sovereignty to a supranational body and those who recognize the necessity for establishing effective regulation before vested interests can be acquired. The rule requires no sacrifice of rights already acquired but provides a means for regulating a medium of communication newly opened to public use.



Although the problem of regulating activities in space is entwined with that of arms limitation, it was thought that nothing was to be gained and much was to be lost by treating these two as one. Limitation of armament under international conventions would have to come through the arduous channels of diplomatic negotiation which, involving as it must the right to self-defense guaranteed under Article 51 of the U.N. Charter, might require a long time.

While the forum considered alternate roads to the goal of regulating activities in space, the prevailing viewpoint was that only an international space authority under the United Nations appeared practical. It was submitted that the suggested criteria and the plan based thereon supported a workable jurisdictional reference system into which space laws of the future could be integrated.

"By the dawn of the year 1960, the technological revolution begun at Kitty Hawk in 1903 had advanced to the point where the United States stood to gain more than it could lose through a return to its traditional military posture and strategy."

Moreover, the proposed rule for the exemption of orbital and superorbital craft from control by subjacent states provided a jurisdictional touchstone from which to proceed to the question of regulation in space independent of the problem of limitation of armaments.

It was anticipated that there would be an executive directorate unhampered by the veto power of any state which would be granted authority to promulgate its own regulations, subject, of course, to the usual limitations, for control of activities in space and administration of celestial territories and given the means for enforcing its regulations through its own worldwide monitoring and policing system.

Provision would be made for compulsory submission of legal disputes to the International Court of Justice or to a court especially created for the purpose with the right of appeal to the Court of International Justice.

ENFORCEMENT would follow the usual pattern, including the licensing of space craft, the monitoring of their activities in space, and the detection, classification, and disposition of unlicensed craft. The space authority could report the presence of unlicensed space craft to the governments of endangered states. Should these not wish to deal with the menace, they could delegate the right to dispose of them to the space authority.

The representative of the State Bar of Michigan at the forum expressed his opinion that such an international authority could be brought about through the United Nations. The avowed bipartisan policy of the United States is to seek international agreement through the agency of the U.N. for the peaceful utilization of space for the benefit of all nations.

If one can judge by the text of proposed resolutions introduced in the

General Assembly by Soviet Russia, the Reds appeared to be in accord with that ultimate goal.

The speaker pointed out that in 1958, on the initiative of the United States, a resolution had been passed in the General Assembly calling for the establishment of an ad hoc committee on the peaceful uses of outer space. In the event that the General Assembly were to elect to refer the question of a space authority to the Security Council on the ground that there *appeared to be a threat to peace* in the present unregulated condition of space, and, should the Security Council fail to act, the General Assembly could declare by resolution that it would assume jurisdiction over the creation and maintenance of a United Nations space authority, thus avoiding a possible veto in the Security Council.

However, legal technicalities aside, the American Bar Association's fundamental approach to the legal aspects of the exploration of space commends itself to a rational mind. In place of some major pronouncement released at the summit, we have a grassroots meeting of the minds on fundamental principles.

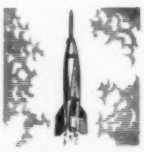
Circulated at the moment when sovereign nations were meeting to formulate conventions designed to govern peaceful exploration in Antarctica, this not only provides a bridge into space but suggests a footpath leading back to the more pressing and much more complex problems of government on earth.

SINCE international civil aviation conventions already project the jurisdiction of sovereign states into the air space, to the end that they may protect persons and property from damage by falling objects, it is logical to extend into the air space the principles of international law already embodied in the rules of war governing the uses of military force.

This would have the effect of re-emphasizing the role of military forces in the execution of international law, and of defining their jurisdictions. It would bring shore-based aircraft under the authority of armies and seaborne aircraft under that of navies.

By the same token, nationally owned space craft would come under the jurisdiction of a space arm to be created for that purpose and held in readiness subject to the orders of the international space agency governed in turn by conventions to be agreed upon.

Indeed, this process ultimately might evolve into a comparable international authority exercising jurisdiction over civil and military uses of the air space.



While a cursory glance backward over the interlude from Kitty Hawk to Sputnik to Polaris may leave a superficial impression that Western civilization has declined at an accelerating pace comparable with that of the technological revolution, a closer look at the inside story of the interplay of societal forces during this era supports the conviction that we are participating in a process of evolution and creation.

Given wise direction this can lead to a higher civilization as measured in terms of individual liberty. Given a leadership among American industrialists such as that evidenced by the American Bar Association, the American ideal of world peace through world freedom under world law becomes an attainable objective.

The objective came into sharp perspective about Christmastime in 1959 when President Eisenhower returned from his 11-nation, 3-continent tour lifted up by his discovery of a deep-seated hunger for "peace in freedom." With an intuition born of his American heritage, he had put an unerring finger on man's highest aspirations when he had spoken of the day "when there can be peaceful partnership, communication, interchange of goods between all nations." Moreover he had paved the way for decisive action at the summit.

It was none too soon, for a new menace had arisen to threaten the lines of communication of the Western World upon which it depended for its commerce, industry, culture, and liberty. The Eastern world, less dependent upon shipping for its autarchic way of life, could exploit the mobility and security which enabled the Polaris system to pinpoint conventional or nuclear weapons on selected military targets without unnecessarily endangering civilian populations, by concentrating nuclear-powered submarines on Western merchant convoys.

The classic hunter-killer tactics which had downed diesel-powered submarines promised to prove less effective against their nuclear successors. The hunter had become less certain of locating the target for the killer; indeed, the only certain way of fixing its position appeared to be through the dubious tactic of waiting for it to attack. This new threat to the communications upon which the whole world depended for access to its sources of sustenance called for decisive action.

THE psychological moment had arrived to issue a proclamation inviting all like-minded peoples to join with us in the establishment of a rule of just and equal world law. At the same moment the United States must publicly renounce the use of armed forces against noncombatants except in the event of a breach of this basic tenet of civilized society, in which case the United States would retaliate in kind.

By the dawn of the year 1960, the technological revolution begun at Kitty Hawk in 1903 had advanced to the point where the United States stood to gain more than it could lose through a return to its traditional military posture and strategy.

While this did not relieve the armed forces of their responsibility for swift retaliation against unlimited warfare it did restore to limited warfare the precedence it had enjoyed throughout American history. At the same time it set the stage for the extension to new technological developments the principles of international law upon which Western civilization had stood.

Meanwhile, diplomatic negotiation had produced in the summit meeting scheduled for 1960 an ideal forum before which the United States could exploit the initiative it alone possessed. The nation which had spread the idea of liberty throughout the world could now fulfill its manifest potential by offering mankind an opportunity to recover a measure of control over human destiny as it progresses into the realm of space.

New Land and Sea Weapons

The 115-mm. boosted-rocket XM70 automatic field-artillery piece, above, is now being tested by the Marines. It weighs only 3,000 pounds and can deliver 6 rounds in 2.5 seconds (Marine Corps photo). The Navy's new Astor torpedo, below, can destroy submarines as well as surface vessels from greater distances than any other operational torpedo (Navy photo).

Will the Tank Survive?

To live on the atomic battlefield our future tank must be a light, fast, armored vehicle with externally mounted gun and a new form of motive power so it can apply the principle of "fluidity of force"

Capt. B. H. Liddell Hart

HAS the tank a future—or is it finished? Can it still play any important part in the military field, and if so, what kind of part and what kind of tank?

Time after time during the past forty years the highest defense authorities have announced that the tank is dead or dying. Each time it has risen from the grave to which they had consigned it—and they have been caught napping.

Here are five examples of such death sentences, recorded in my files. In 1928, when the world's first experimental armored force was disbanded by the British War Office after two years' trial, an official spokesman declared to the press that "tanks are no longer a menace." In 1932 General Edmonds, the head of the Historical Section of the Committee of Imperial Defence, confidently assured me in a letter that: "Any tank which shows its nose in the open . . . will be knocked out at once. . . . The wars you and Fuller imagine are past."

IN 1934 the British Secretary of State for War, Mr. Duff Cooper, predicted that in a few years' time "the most heavily armored tanks" would be as vulnerable to the new antitank weapons as "an old wooden caravan." A year later the Germans, disregarding his warning, formed their first three Panzer divisions, and five years after that the defenses of the West were overrun by the tank drive that Guderian led.

Captain Hart is a distinguished authority on armored warfare and one of Britain's leading military analysts. He is the author of several books including "The Rommel Papers" and "Strategy."

The sweeping victory of these armored forces momentarily opened the eyes of Britain's leaders to the practical value of the new theory that had been conceived there but neglected by them. They belatedly began to build armored divisions like the Germans. A similar effect was produced on America's leaders.

Even so, the cry that the tank was in decline arose afresh whenever tanks met a temporary check. The cry became particularly strong after the campaign in Sicily and Southern Italy, when the mountainous country normally cramped armored mobility. That affected the preview of its potentialities in the 1944 invasion of France. Churchill had one of his periodical reactions and in February declared, "We have too much armor—tanks are finished."

His doubts were fanned by his official advisers. The Chief of the Imperial General Staff, Field Marshal Sir Alan Brooke, addressed a conference of British and American generals and there sounded a keynote that warfare was "back to 1918," and the lightning drives of 1940 were no longer possible. The U. S. high command was affected by this slow-motion view.

Yet a few months later, the American and British armored forces, breaking out from the Normandy bridgehead, drove swiftly forward to within close reach of Germany, unchecked by the enemy. Unfortunately they were then halted by shortage of fuel supplies, due to lack of administrative preparedness to exploit the great opportunity. If there had been more foresight on the top level, the war would have ended that year.

Five years after the war, many top-level soldiers in America and Britain were talking in just the same manner as before. On the eve of the Communist invasion of South Korea in 1950, the U. S. Secretary of the Army voiced such views in predicting that "tank warfare as we have known it will soon be obsolete." But immediately afterward the defense of South Korea crumpled under the impact of a small number of obsolescent tanks.

Now, a decade later, another wave of disparagement has arisen—inspired by the belief that the new antitank guided missiles have "sounded the death knell of the tank." This belief is at least dubious and could be very precarious for any army which discards tanks to fight the enemy's tanks in favor of guided missiles, either manually controlled or guided to the target by a "homing" system.

These missiles are bulky and heavy compared with the shells fired by a tank, thus limiting the amount of ready ammunition that can be carried, while the "homing" kind are liable to interference and electronic countermeasures. Guided missiles are slow in response and flight compared with the gun in a tank, thus giving the attacker who has a large number of tanks more chance of swamping a defense which relies on missiles to stop them.

The low speed of response and flight allows the enemy tanks sufficient time to move into cover before the missile arrives—behind a tree, hedge, hayrick, house, mound, or slope. A tank that is firing from a "hull-down" position has only to reverse a few yards to get under cover and become invulnerable.

Moreover, the relative slowness of response by the missile gives the tank a good chance of knocking out the launcher before it can shoot. The technique of tank gunnery has developed immensely since 1945 in its combination of speed and precision—so much so that it amounts to a new technical "breakthrough."

This striking development in tank gunnery is a fresh reenforcement of the inherent value of tanks compared with other arms. The basic factors and most distinctive features in tank operations are speed and flexibility. These twin qualities are of more fundamental importance that the armor of the tank. They give its armament, which is not in itself unique, a unique quality in action.

THESE twin qualities remain essential and have even gained in importance with the coming of nuclear weapons. For the strategic problems of the present time, in a world that lies under the shadow of the catastrophic nuclear cloud, depend more than ever on the time factor throughout the whole range of risks from a minor "brush-fire" outbreak or sudden local pounce upward to all-out war.

At every stage, and every level of command, the prospects depend on alertness, immediate readiness for action, maneuverability in switching forces, and rapidity of intervention.

Such a combination of qualities is essential not only for military success but, above all, for averting the fatal spread of a local outbreak into a world conflagration.

The development of thermonuclear weapons has gone far to annul the prospects of success in all-out war, because that kind of war is so likely to result in mutual annihilation. So the likelihood of another "great" war has greatly diminished. But the possibilities of "limited war" have not diminished to the same extent and even have been increased.

Thus an aggressive power is able to exploit a choice of strategic techniques, different in pattern but all planned to make headway for the aggressor while causing hesitancy on the other side—especially in taking the fateful decision to order counteraction with nuclear weapons. Such aggressive moves might be made at a carefully limited pace—by a gradual process of encroachments.

Alternatively, they might be made at a swift pace but to a limited depth—sudden pounces quickly completed and as quickly followed up by a conciliatory offer to negotiate. They might also take the form of stirring up or exploiting internal revolt in another country and then infiltrating or parachuting reinforcements of "volunteers."

Although internal outbreaks call mainly for infantry to restrict and suppress them, mobile armored troops can do much both to damp and disperse them. In meeting more direct aggression they form the most effective answer to a sudden pounce. Moreover, if such limited aggression should spread and develop into nuclear war, an armored force has a much better chance of survival and of movement than infantry.

"A force operating in a dispersed swarm of small battle-groups, under radio control, can have multiple effect without ever offering a concentrated target to air attack or a nuclear burst. A swarm of hornets do not concentrate—they attack from all directions simultaneously. Their practice demonstrates the meaning of 'multiple effect'—the guiding idea for tactics of controlled dispersion."

Armored forces, however, need to be remodeled on a more flexible and less vulnerable pattern. That is essential, because the threat of nuclear bombing or missile bombardment will be a constant shadow. It also is essential to avoid being disrupted or paralyzed by non-nuclear air and missile attack. Every vehicle in an armored force ought to have cross-country mobility and sufficient protective armor to keep out bullets and splinters from shells and bombs.

The incorporation in an armored force of men who can fight on foot is a tactical necessity for ferreting out enemy troops who are under cover behind obstacles, and for various defensive tasks. But it is a basic error of organization if the proportion of infantry exceeds the proportion that fights mounted, manning armored fighting vehicles and self-propelled guns. "Armored fighting men" ought to be preponderant in an armored force if it is to justify its name and fulfill its purpose.

FOR tactical efficiency the "mounted infantry" element of the force needs to have a cross-country mobility closely equivalent to that of the armored fighting element. This condition can be met only if the whole of the infantry element is carried in armored personnel carriers. Otherwise it will not be able to accompany the tanks closely enough for prompt action to clear defended obstacles which block the tanks.

There is abundant experience to show that the quicker these "foot fighters" can intervene the fewer will be needed. A company of armored infantry coming into action immediately they are needed, might brush away resistance that a whole battalion of ordinary motorized infantry, brought up later, could not overcome when the obstacle has been reinforced. Time is decisive in war, especially in quenching a local threat before it spreads into a general conflagration.

There also must be a drastic reduction in vehicles and supply requirements in order to attain adequate mobility. To that end armored troops ought to apply the principle that Sherman prac-

ticed a century ago and by which he revived mobility in the later stages of the Civil War prior to his advance through Georgia and the Carolinas.

Modern mobile forces likewise must learn how to "slim"—to reduce their military "fat" in order to increase their mobility and endurance. They ought to be capable of self-contained operation for several days, or even weeks, instead of being tied to vulnerable lines of supply.

Moreover, supply by air needs to be employed to the fullest practicable extent—and this should become more fully possible as the helicopter is improved or is superseded by new ground-hopping vehicles. That would also enable a reduction of the foot-fighting and other auxiliary elements.

While much can be gained by organizational progress, it is no less important to achieve a new advance in tank design. A fresh trend is already developing. Successive efforts to mount a bigger gun and thicker armor trebled the weight of tanks in the course of the last war at the expense of tactical agility and strategic mobility. The heavier types of tank became, and remain, a serious handicap to speed and flexibility of maneuver, strategic and tactical.

The tank of the future will need to be fitted with night-driving vision and with radar if possible. It should also be able to pass safely over a radioactive stretch of ground. If such requirements were to be combined with a heavy gun and heavy over-all armor, the tank would become an increasingly clumsy monster. The development of the guided missile is likely to cut short the reign of such monsters, while providing a substitute for their role.

SO our primary objective should be a lighter tank of greater firepower through the development of a new and lighter kind of hard-hitting weapon and an effective way of mounting the main weapon externally instead of in the turret. Lighter-weight protection should be developed to replace the present armor plate, and a new form of motive power. We must always be seeking a technical break-through to achieve a revolutionary change. Meanwhile, we should strive to reconcile an effective gun-armor combination with maneuverability, keeping constantly in mind the guiding principle "smaller and better."

Our goal in tank specification and design should be to produce a mechanized David instead of a Goliath. We should aim to get a thoroughly effective battle tank that is capable of being carried by air. That means a weight, under present conditions, of not more than 22 or 23 tons. Moreover, 30 to 40 tons is about the maximum for effective logistical properties under any physical conditions we can visualize.

Beyond the importance of lighter tanks, there are also other lines of development leading toward greater mobility and flexibility. One of these is the development of new kinds of obstacle-clearing equipment; another, new kinds of tank bridging equipment or, better still, new flotation devices to make any tank capable of swimming rivers without having to pause more than briefly for adjustment and without diminution of its fighting efficiency.

It is also very important to develop helicopters or other new forms of direct-lift aircraft for supply, except in first-line transport. In such transport we need vehicles with greater cross-country capabilities. A still greater advantage is promised through the prospect of air flotation—by the fuller development of "zero ground pressure" vehicles, capable of short grasshopperlike jumps over obstacles or of more lengthy tactical hops to the scene of action on the ground.

A further need, particularly for an army that has to deal with overseas emergencies, is for an adequate scale of tank-landing ships. It becomes more essential for an oceanic power, as the prospect of strategic air movement is becoming restricted by the increasing unwillingness of continental countries, especially in Asia and Africa, to allow the use of bases on their territory, or even flights over it.

"The basic factors and most distinctive features in tank operations are speed and flexibility. These twin qualities are of more fundamental importance than the armor of the tank."

Changing conditions also call for changes in tactics. The offensive and counteroffensive success of armored forces in World War II was dangerously dependent on freedom from air interference. It would be fatal folly to dream that armored forces could, as they did then, operate in mass and deliver concentrated punches beneath an enemy-dominated sky—or in the face of nuclear weapons. The "principle of concentration" must be interpreted and applied in a new and more fluid way, with the aid of a new technique of "controlled dispersion."

Controlled dispersion differs essentially from piecemeal distribution. A force operating in a dispersed swarm of small battle groups, under radio control, can have multiple effect without ever offering a concentrated target to air attack or a nuclear burst. A swarm of hornets do not concentrate—they attack from all directions simultaneously. Their practice demonstrates the meaning of "multiple effect"—the guiding idea for tactics of controlled dispersion.

NOW that the development of nuclear weapons has led to a situation of nuclear stalemate—only breakable through mutual suicide—the traditional aim of "destroying the enemy's main armed forces" has become obsolete and utterly absurd. To pursue such an absolute aim is the surest way to induce on the opposing side a feeling of desperation that will produce mutually fatal results.

Strategically and tactically, the only sensible aim now is not the destruction but the *paralyzation* of the enemy's action. In pursuing this aim the capture or maintenance of positions will count for much less than the domination of areas—which is best achieved by offensive (and counteroffensive) fluidity of force.

Such "fluidity of force" is a principle that fits the future, because it is adapted to the new conditions, and mobile armored forces are particularly well fitted to fulfill it.

Flexible Air Research

With scientific investigation now on an equal plane with Air Force engineering, exploration of still-unknown areas of the natural law may reveal phenomena of vital importance to the national defense

Brig. Gen. B. G. Holzman

SCIENTIFIC research now receives greater emphasis and encouragement in the Air Force than ever before. Out of the exhaustive reorganization of the Air Research and Development Command initiated last October by Lieut. Gen. B. A. Schriever, research for the first time emerges on an equal plane with development. While some lines and blocks remain to be drawn on the new organization chart, the pattern has become clear enough for us to discern some important implications for research.

As originally set up a little over ten years ago, ARDC was a strong headquarters operating through a far-flung network of centers and center-level offices. Under this concept of strong central management, ARDC was responsible for virtually every phase of operation, as well as for policy and planning. However, over the years, the distance between centers, plus the influence of the accelerating rate of technological development, led gradually to overlapping programs in certain critical areas of science.

DESPITE this, an impressive number of successful aeronautical and aerospace weapon systems came out of ARDC's centers and laboratories to keep the Air Force abreast of military requirements. However, it became apparent, especially with the quickened pace engendered by the launching of the first manmade satellite, that ARDC would have to be redesigned to achieve a more cohesive program, to reduce the demands on the time of the commander, and to shorten the period between the conception of an idea and the emergence of a piece of hardware.

General Holzman is Commander, Air Force Research Division, Washington, D. C.

On the recommendation of Gen. Samuel A. Anderson, then commanding ARDC, the Air Force appointed a committee of distinguished scientists to study the existing structure and evaluate possible changes. Another survey was undertaken by a group of ARDC staff officers. On General Schriever's accession to the command, a staff study was ordered which led to the plan which General Schriever announced at a news conference in the Pentagon on October 6, 1959.

Briefly, the plan envisioned the conversion of ARDC headquarters into a long-range planning and policy organization, with most of the operating authority delegated to four division commanders in the field. Accordingly, the headquarters is becoming a more streamlined structure than it was, with a Chief of Staff, Special Staff, and six Deputy Chiefs of Staff. The heterogeneous laboratories which had hitherto been assigned to center commanders on the basis of geography are being evaluated for assignment to appropriate division commanders on the basis of mission.

Of the four divisions, one was already in existence and served as a prototype for the others. The Air Force Ballistic Missile Division at Inglewood, California, had been organized by General Schriever to accomplish the rapid and orderly development of the Atlas, Titan, Thor, and Minuteman ballistic missile systems required for maintenance of America's deterrent strength. BMD will continue to have prime responsibility for the development and testing of the Air Force's ballistic missile and space systems.

The second division to come into operation was the Wright Air Development Division, at Wright-Patterson Air Force Base, Ohio. WADD will have cognizance over the development of future aircraft vehicles, including aircraft, aerodynamic missiles, missiles associated with aircraft, and certain manned aerospace and supporting systems.

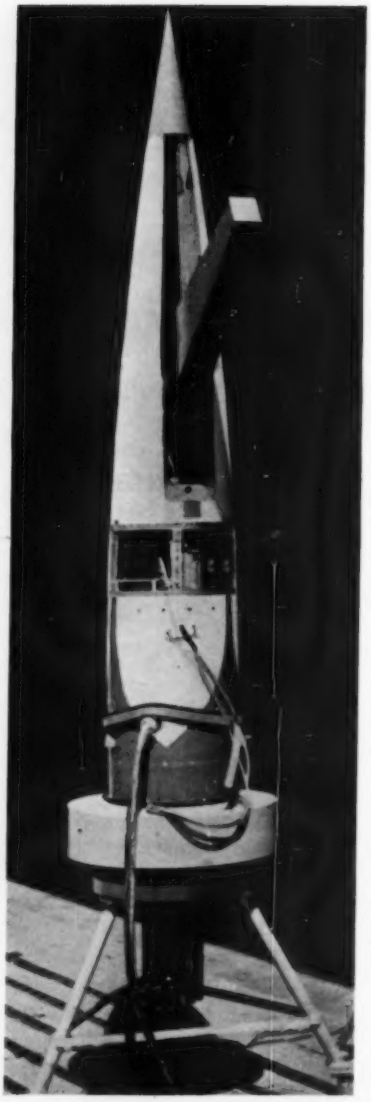
Next came the Air Force Command and Control Development Division, familiarly known as C^2D^2. This division, with headquarters at L. G. Hanscom Field, Massachusetts, will develop the complicated communications and electronic control systems required for modern aerospace operations.

Finally on January 15, 1960, came the Air Force Research Division, with headquarters in Washington, D. C. The first elements phased into AFRD were the Air Force Office of Scientific Research and ARDC's European Office in Brussels, Belgium. These organizations have a unique bond in that they are the only elements in the Air Force which support scientific research entirely by contract and grant, rather than in in-house laboratories. They will retain their unique identities and missions within the Research Division.

Other parts of ARDC are being considered for orderly inclusion into the AFRD complex, including the Aeronautical Research Laboratory at Wright-Patterson AFB. Other research units may be brought in as the Division headquarters becomes strong enough to provide the necessary direction and support. The Research Division may also have technical supervision over specific research projects retained by or set up in the development divisions.

More important than the specific bits and pieces entrusted to the Research Division is the philosophy of research management which has evolved. Essentially, it boils down to the answers to three searching questions:

1. How do you conduct research under a "systems concept" of development? 2. How do you make sure that the fruits of scientific discovery will flow into the developmental channels promptly and smoothly? 3. How do you achieve a proper balance between in-house and contract research? I believe that AFRD will provide the answers to these questions.



Housed in the nose cone of an Aerobee rocket, this monochromator recently took the first photoelectric measurements of solar radiation in the ionosphere.

THE first requirement for enlightened, progressive research management, it seems to me, is flexibility. This is one of the virtues whereby AFOSR and the European Office achieved the confidence of the scientific community. We are always ready to discuss and, when feasible, approve a change of direction or a change of emphasis on a project under way. We are always ready to augment our support of a project which has reached a significant stage. Flexibility permits us to support several different approaches to the same problem and to bring the findings of one investigator quickly to the attention of others to whose work they might be applicable.

A second requirement for our research management is the ability to see the potential implications in a proposal. It is axiomatic that the only true purpose of basic research is the discovery of natural laws—science purely for the sake of acquiring knowledge. Further it is a fact that the future of our country as well as the Air Force is dependent on continuing emphasis on basic research. Strong in the conviction that the tax dollar which is allocated to the Air Force should buy only one thing—the strongest possible defense—an increasing proportion of these funds is set aside to support scientific investigation. The selection of a specific proposal is determined by our best judgment as to the competence of the investigator and the relevance of the investigation to the interest of the Air Force.

A GOOD research scientist with a bee in his bonnet couldn't care less whether his idea has a military connotation. In fact, most "pure" scientists recoil from any suggestion that there ought to be any "taint" of practicality in their work. But they have learned that this does not present a formidable obstacle to our support of their projects. The recognition of Air Force interest in a given proposal is the function of our own scientific staff—a function which our staff scientists perform regularly with remarkable precision.

A third requirement for a successful research manager is the ability to recognize when a project is ready for transition into technical development. This involves a comprehensive familiarity with the missions and operations of the development divisions and a working relationship under which our recommendations will be received with confidence and respect. It also involves an intimate knowledge of the long-range goals of the Air Force and sensitive analysis of military and scientific intelligence.

The next requirement is the one which is most difficult for a military organization to accept, particularly on the higher command levels where the crucial decisions of manpower and money allocations are made. This is the understanding that scientific research is purely exploratory and that, when you explore, you can't be really sure of what you'll find. Negative results, like positive results, pass into the scientific literature and are valuable in steering future research into more fruitful channels.

By virtue of the years of indoctrination in the military philosophy which requires winning for success and equates a negative result with failure, a stra-

tegically placed officer may find it difficult to accept the tenet that a temporary scientific failure is valuable. However, whenever such a philosophy has threatened to "turn off the money" for research, we in the Air Force have always been fortunate enough to have the backing of enlightened top officials. It sometimes took intestinal fortitude in the true sense of the term for these high-level civilians and officers to stand up time after time for those who wanted to spend hard-won Air Force money for projects which might be construed as "scientific boondoggling."

Many top Air Force officers have come around to the view that *any* basic research *must* eventually benefit the Air Force. Nevertheless, since our funds are not unlimited, we can support only about one out of six proposals that come to us. Therefore, we have an obligation to scrutinize all the proposals and ideas and select those which seem to hold the greatest potential for use.

GENERAL Schriever has given the Air Force Research Division cognizance over *all* basic research in or supported by the Air Force. As part of the requirement for flexibility, I consider it likely—and even desirable—that the development divisions will keep some research capability in their own organizations. As they pursue their system goals, they will from time to time feel the need for specific research that is not currently being sponsored by AFRD. In such a case, it seems proper to me for the Development Division to ask us to undertake it or even to contract for it directly.

Some basic research projects may seem rather irrational. At a meeting of the Air Force Association last year, one of my colleagues mentioned the training of octopuses among many other research interests we had. The talk was covered properly by most of the reporters present, but unfortunately the representative of one of our most influential newspapers chose to lift the octopuses out of context and treat them with levity. Soon afterward I was asked by some critical superiors for the report cards from my octopus school.

Fortunately, I was able to convince them that we have a legitimate interest in octopuses, but thus far we haven't been able to distribute the true story to the vast audience of taxpayers who read the hilarious story about our "scientific boondoggling."

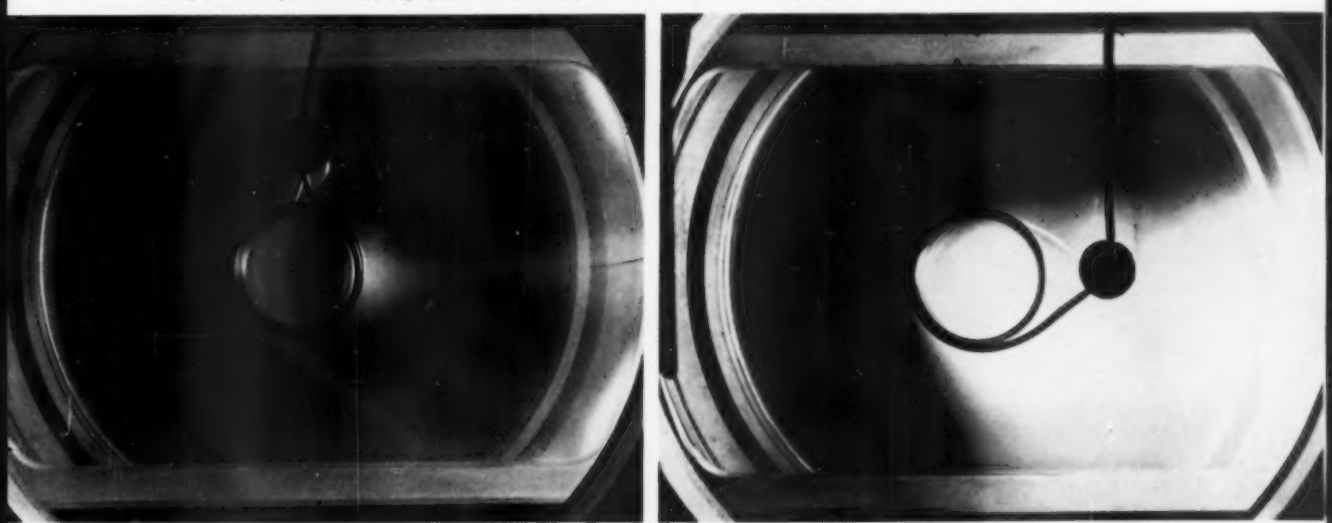
Briefly, we are interested in learning how the brains of animals work. There are two reasons for our interest, both with strong military implications.

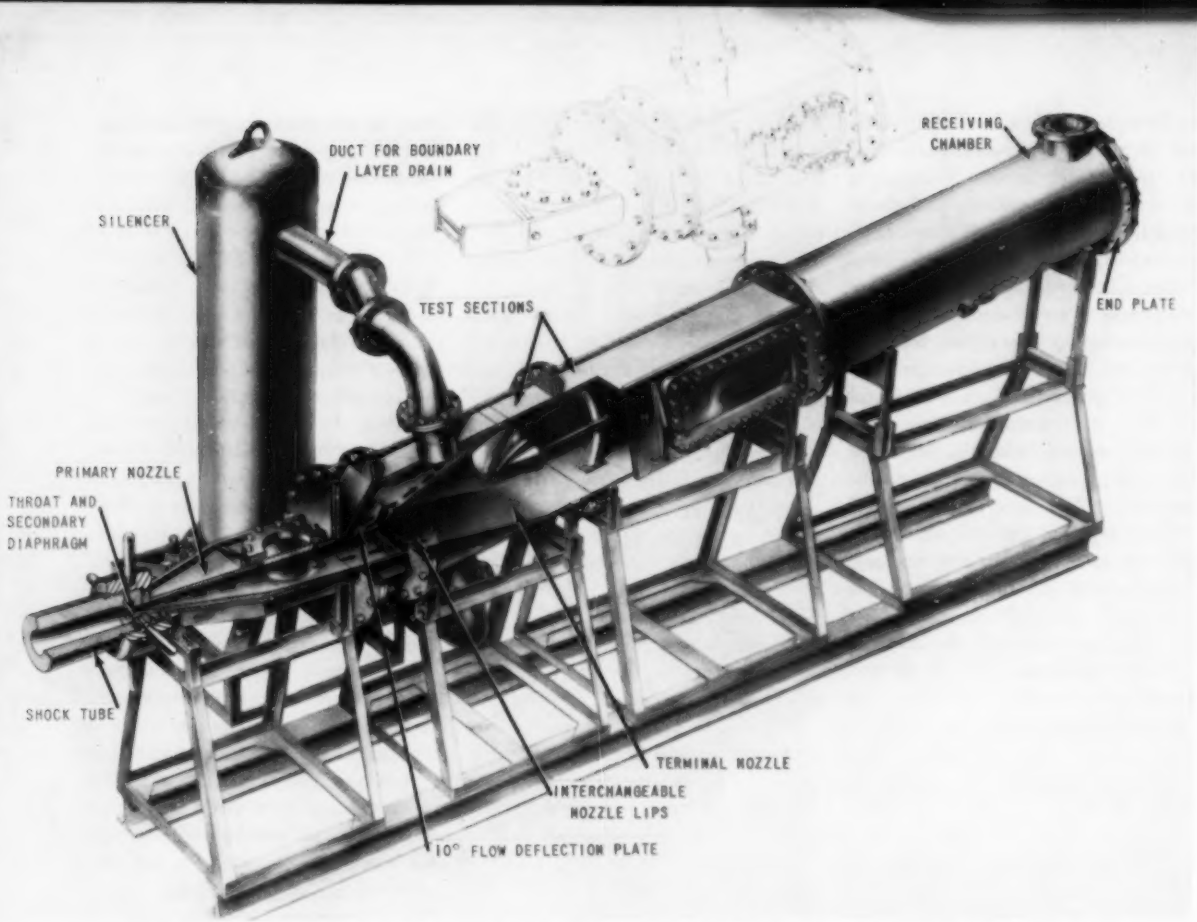
The first reason is the needed improvement of the so-called "mechanical brains" or "giant brains." These boxes of electronic gadgetry are steadily becoming more profuse, more intricate, and more essential on military rockets, missiles, satellites, and airplanes.

YOU are no doubt aware that the term "brain" for a black box is a misnomer. These boxes aren't brains at all; they're computers. They are marvelous computers and I do not intend to disparage their value for the purpose they serve. They calculate with impressive rapidity and a very high degree of accuracy, but even the most sophisticated of them can use only whatever information has been fed into them by the "programmers," and they can use no judgment at all.

Even the lowest form of animal life has an intelligence which can study and evaluate the organism's environment through various senses which it controls, analyze the information thus received, make a rapid decision, and direct the muscles to effect the desired end. Have you ever seen a frog flick out its tongue and snag a fly that happened to be passing within reach? *That* is lightning calculation based on intelligence—and it is far beyond the powers of the most marvelous "mechanical brain" ever devised. Some day we may have a mechanical brain which could be sent on a military mission with instructions to analyze

Demonstrating lift by flow deflection of an ionized gas through a magnetic field. Left, with no magnetic field in coil, flow is symmetrical; right, flow is deflected to lower right, inducing upward lift, when coil is energized.





An 11- by 15-inch hypersonic shock tunnel used for experimental study by the Air Force Office of Scientific Research.

the situation and act accordingly. To get it, we must start by learning how an animal's brain operates. This we do not know.

IF we should ever learn how the human brain receives and evaluates information, we can achieve the second military goal of this kind of research—the improvement of training methods for aerospace crews for ever more challenging assignments. At the moment, however, we have almost no knowledge of how a simple brain operates, let alone the complex mechanism of the human brain. The old principle of walking before you run dictates starting with a comparatively simple intelligence. The octopus' brain is not the simplest, but it is simple enough and has the added virtue of being readily accessible.

Our life scientists are principally interested in the visual sense of the octopus. The creature has very keen vision, but his eyes, while in many ways similar to ours, are built on so different a plan that, for all practical purposes, we are investigating a totally new kind of optical apparatus. In a way, the octopus is giving our scientists a foretaste of the problems they may encounter if our astronauts actually begin to find strange life forms on other planets. The octopus evolved on earth, but his evolution was so radically different from that of the vertebrates that he might truly have come from a distant world.

To revert to the mundane, scientists under contract to the Air Force Research Division are training octopuses to respond to signals in order to determine the powers and limitations of various parts of the creature's brain, including especially its optical powers. When the final report on this project is written, we will be an important step forward on the long road toward understanding our own mental mechanism.

A somewhat similar investigation of animal vision, this time that of a beetle, has had an unlooked-for pay-off, which illustrates the fascinating quality of seredipity in basic research. The scientists learned that the beetle judges speed by the length of time it takes for one of its ommatidia (the facets of the beetle's eye) to spot something after another ommatidium has seen it. The logical extension was to substitute photoelectric cells for the ommatidia and place one at each end of an airplane. With appropriate integrators and other electronic units, we should have the most accurate ground-speed indicator ever devised. This discovery is now being followed up by our sister division, the Wright Air Development Division. This affords also a fine example of the natural and orderly progression of a research result into development.

WE have a number of other projects involving the mechanism of animal intelligence, as well as other promis-

ing studies on both the biological and behavioral sides of the life sciences. We are most heavily engaged, however, in the more material sciences of aeronautics, chemistry, and physics. Research projects in these fields have had their share of practical payoffs. For example:

1. A few years ago we put a comparatively small amount of money into a project that some eminent scientists and some skeptical superiors told us was a "screwball" idea and basically unsound. Out of this came the prototype of the magnetohydrodynamic generator. A great research corporation and a dozen large electric-power companies are now putting several hundreds of thousands of dollars of their own money into developing this idea on a commercial scale.

2. A project fostered by our solid-state scientists culminated in the microscope which first enabled researchers actually to see and to photograph individual atoms. The implications of this one discovery for the development of new materials and the improvement of existing materials must be clearly manifest even to the untrained layman.

3. An investigation in the reduction of "drag" emanating from a vehicle moving at supersonic speeds produced results which the aircraft industry is now incorporating into existing and planned supersonic vehicles.

4. In basic chemical research, an investigator succeeded in producing a hydrogen-fluorine flame which has the highest known burning velocity. It should be valuable in studying flow patterns of exhaust gases from missile propulsion systems.

5. The same scientist created a cyanogen-oxygen flame which burns at 4,500° centigrade. This found an unexpected home in the Harvard Medical School. Acclaimed as virtually the first new spectroscopic flame source in half a century, it is used to analyze as little as one-third of a drop of body fluid for seventeen different trace metals.

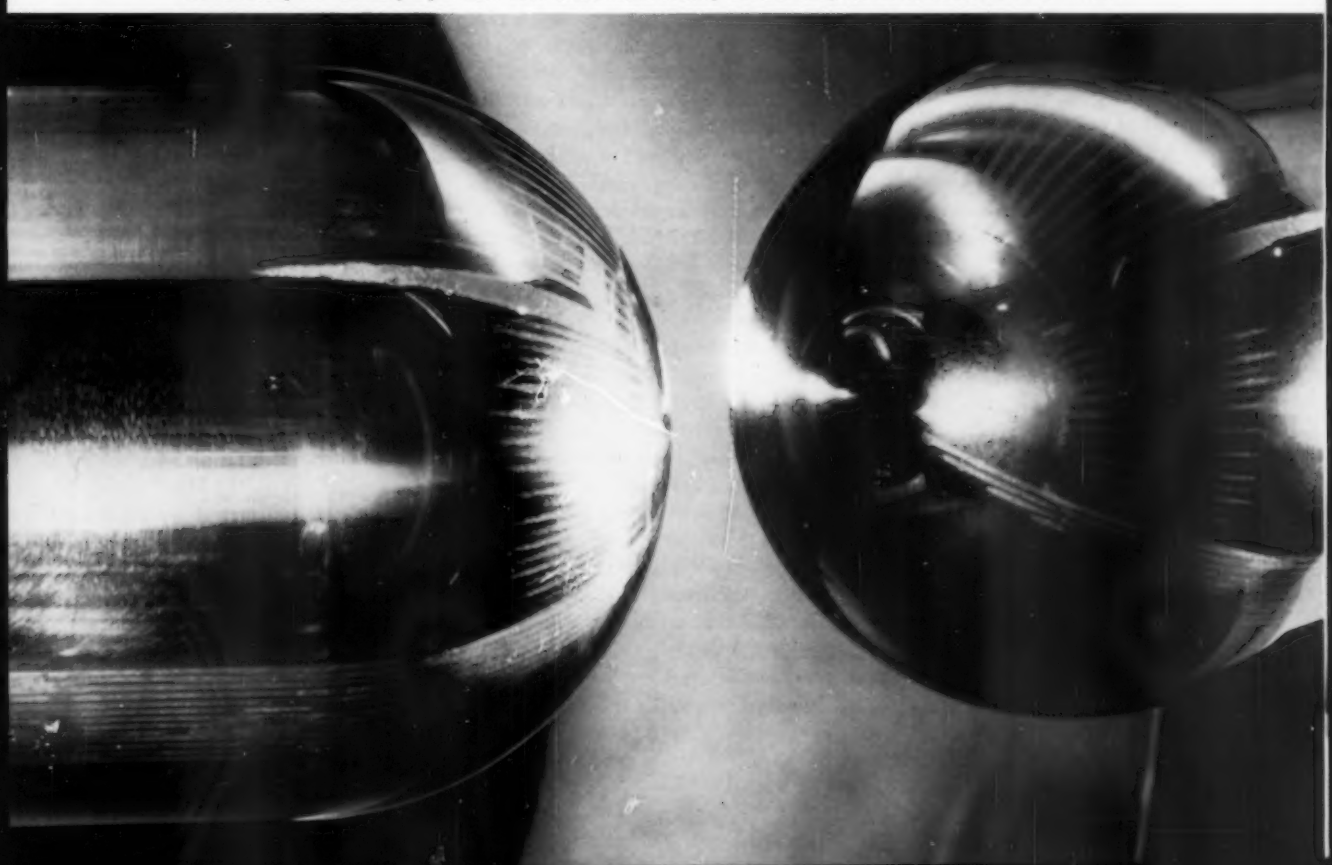
6. Other chemical scientists have produced quartz fibers, both metallic-coated and uncoated, which are stronger than equal thicknesses of steel. This introduces a new material with unequaled properties for use where resistance to high temperatures is important.

7, 8, 9 and 10. We bought research in which the size of the neutron was determined for the first time; a highly efficient gas amplifier for radar frequencies was developed; damaging effects of particles of meteoric speed on surfaces were determined; and heat transfer from high-speed gases to metal surfaces was calculated.

THESE few samples merely scratch the surface of the contributions that basic research has already made to the existing and future strength of the Air Force. AFRD has about 1,000 contracts in force during the course of a year. Some of them may be years away from practical applications, but break-throughs do occur overnight.

With research now at last on an equal plane with engineering in the Air Force, we are enjoying a climate in which the Air Force Research Division can accelerate the exploration of still-unknown areas of natural law in which lies the future of our Air Force, our Nation, and the free world.

An azo-benzene coating is used to observe behavior of boundary layers at Mach 3 to 5 in high-speed wind tunnel study of boundary-layer flow over blunt-nosed reentry bodies. Body at left is reflected in a mirror.



Battle at Brandy Station

Fairfax Downey's recent book tells the exciting story of this little-known cavalry engagement of the Civil War where more superbly mounted men fought than ever before in this hemisphere

Lewis L. Strauss

A STACCATO of rifle fire by surprised pickets who had camped during the night beside a tree-shaded ford shattered the misty morning silence of June 9, 1863. So began the battle of Brandy Station, fought on the rolling hills which lie just south of the Rappahannock River in Culpeper County, Va. The engagement which lasted throughout the day was notable for a number of events, although history has overlooked it in any detail.

It was the greatest cavalry battle of the war. The slaughter of thoroughbred horses, which already had wiped out some of the most illustrious bloodlines, had not yet deprived the cavalry of Jeb Stuart of mounts to match the mettle of the men who rode them.

In charge and countercharge across the open fields and over the snake fences of split-chestnut rails as though following hounds in happier days, there rode against each other that day more superbly mounted men than ever before or since have fought on one battlefield in this hemisphere.

BUT other than a half-hidden tablet on a by-passed stretch of country road, no monument marks this epic terrain. Even the name, "Brandy Station," whose mention used to set the blood of veterans tingling, had nearly disappeared. The tiny railroad depot and post office had shortened it to "Brandy" years ago, and so it was until a recent and long-needed revival.

This is a review of Fairfax Downey's "Clash of Calvary —The Battle of Brandy Station (New York: David McKay Company).

Lewis Strauss is former chairman of the Atomic Energy Commission. During World War II he served with distinction in the Navy as a rear admiral.

One of Stuart's aides in 1863 was a towering young German soldier of fortune, standing nearly seven feet tall in his cavalry boots. Like so many European officers, he had crossed the Atlantic and enlisted from sympathy for one of the combatant causes or to gain military experience and laurels. Late in his life which, after the battles in Virginia, had been anticlimax, he wrote a book about this day of blood and bravery.

His name was Heros von Borcke, and his book, "Die Grossee Reiterschlacht bei Brandy Station," was, until recently, almost the only source of information about the battle. But at the time of its writing, the dashing young cavalryman had grown old and his memory was dim and events had escaped the focus of accuracy.

In consequence, a battle which marked the beginning of the Gettysburg campaign and the end of the complete superiority of the Grey cavalry over the Blue had receded far into forgetfulness. It was high time for it to be rescued from oblivion, and the distinguished historian, Fairfax Downey, has handsomely performed this service. His book is a delight to read, not only for his ability to evoke the persons and the scenes he describes but also because his intimate familiarity with the military paraphernalia and the tactics of cavalry and artillery give to his words the ring of authority and accuracy.

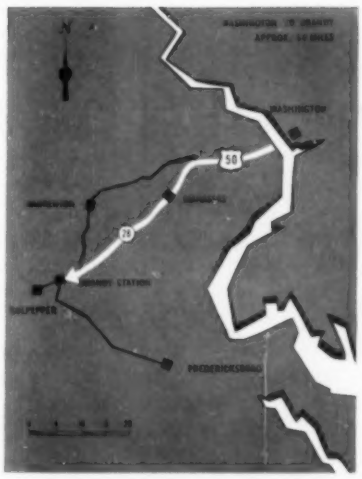
MR. Downey has marshaled every fact that has survived in the old reports and the faded letters and diaries of the participants. He recreates for us the review of Stuart's command on the day before the battle, there on the level fields west of the old Orange and Alexandria Railroad between Brandy Station and Culpeper Court House. Genral Lee himself has been invited and persuaded to ride out and take the salute. The mounted squadrons pass him at a walk, then at the trot, and finally at the charge, sabers flashing. With blank volleys, Stuart's 6-gun battery of field artillery contributes smoke and sound to the occasion.

Northward, across the Hazel River, a quiet-flowing tributary of the Rappahannock, Union pickets hear the cannonade. What does it mean? Early next morning, Gregg and Pleasonton cross widely separated fords to see if they can discover what is afoot. Before Stuart is aware of it, Gregg is already around his right flank and between

him and Culpeper, while Pleasonton's cavalry at the trot is moving up the hill to the little woods where the six field guns and Stuart's headquarters are camped. The battle is joined.

When the fighting is over at nightfall, the guns have been used by both sides. Captured and recaptured time and again, wheeled about before they could be spiked by defenders, they are heaped around by the bodies of the men who served them, Blue and Grey alike. All over the rolling fields lie the dead and the wounded—the men and the horses. Sabers and scabbards, guidons, stirrups and leathers, spurs, carbines, canteens—the terrible broadcast of matériel which armies scatter in such awful largesse is everywhere.

The Union forces withdraw and the field is left to Stuart. But the price on both sides has been high in brave men for whom the war is over. Mr. Downey describes the day with a wealth of detail which makes the picture come alive. The heroic figures on both sides are seen in full scale. The noise and the dust, the sweat of men and the lather of horses, and the heroism and courage are vividly recalled.



Geographically, Brandy Station is within sixty miles of Washington.

The last veterans have been buried. The scars are all healed and there are those today who would forget a war which, in retrospect, seems to have been so unnecessary. But courage and daring and self-sacrifice are traits which a nation must encourage. The future may have need of them as has the past. And how better to preserve them than to celebrate, as does this book, the deeds of those who set examples of devotion to cause and country which they held more precious than life.

In sending his review to ORDNANCE, Admiral Strauss made this comment:

"My grandfather had settled in Culpeper in 1849 and the family lived there during the war. Men who had been wounded at Brandy Station and Kelly's Ford were tended in the parlor of the house in which the family lived in Culpeper. One of them gave my father's older sister who had nursed him a doll which now is in the Confederate Museum in Richmond.

"My farm in Virginia covers much of the battlefield and my house overlooks it. Once on an afternoon years ago as my son and I sat on a terrace overlooking the hills and valleys toward the Blue Ridge, a mist which had gathered over Ruffin's Run, a little stream which winds through the fields, was caught by a breeze and moved toward us up the hill. With its ragged banners of vapor blowing ahead, it was easy to imagine a ghostly troop of horsemen—and I told my son the story of the battle."—THE EDITORS.

Union cavalry charge near Brandy Station (photo courtesy Library of Congress).

Truce of the Bear

The Communists have predicted that they will begin their attack on capitalism by launching the most spectacular peace movement on record but that they later will smash us "with the clenched fist"

Maj. Reginald Hargreaves

AT the present stage in world progression "popular" governments are not put into office to do the right thing, irrespective of consequences, but to refrain from doing what the people fear.

In 1938, for example, we were regaled with the spectacle of a British Prime Minister flourishing a scrap of paper bearing Adolf Hitler's signature and claiming to have engineered "peace in our time." With a similar parade of confidence, an American President, a couple of years later, assured his fellow-countrymen that their sons would never be sent overseas to fight in a foreign war.

Now either these two eminent individuals were afflicted with a credulity that approximated closely to the cretinous, or they deliberately doled out their respective spoonsful of soothing syrup because they had accustomed themselves to leading their people only where they wanted to go—even if the road they followed led to a Gadarene abyss.

AS the patriarch Jeremiah bewailed: "The prophets prophesy falsely . . . and my people love to have it so."

In times of pestilence quacks flourish; in times of financial chaos economists are all the rage; in times of political tension and unrest the only Ajax to command attention, it seems, is the one who is prepared to negotiate with the lightning rather than defy it.

Major Hargreaves is a retired officer of the British Army and a well-known historical writer. His latest work, "The Narrow Seas," was reviewed in a recent issue of ORDNANCE *magazine.*

It is a new and fearful thing that democracy should have come to prefer illusion to reality; that it can seriously interpret Khrushchev's ability to "smile and smile and be a villain" as an "improved atmosphere," a "better climate of opinion." It is a new and shameful thing that in its obsession with its dream-image of a world of ever-increasing material benefits it should be prepared, by implication, deliberately to condone tyranny and act as mute accomplice in the continued enslavement of populations running into millions.

Yet what other conclusion can be drawn from its groveling readiness to negotiate with the unrepentant satrap of Soviet imperialism, even to the point where its "leaders" are "led" by the pressure of public opinion into seeking a summit conference with him?

Has it already been forgotten that in 1945 the Kremlin's slogan was: "The war on Fascism ends; the war on Capitalism begins"?

Karl Marx openly averred that before Communism could triumph the British empire and the United States republic would have to be destroyed. That was accepted—and such it remains—as the cornerstone of Kremlin policy. For the very existence of a free society embodies a standing challenge to a regime based upon a despotism as adamantine, or as momentarily relaxed, as its arbiters choose to make it.

LENIN early gave recognition to Marx's fundamental doctrine when he wrote: "So long as capitalism and socialism exist, we cannot live in peace. We are left, therefore, with the prospect of a state of coexistence which means the absence of both peace and war in the full sense of both words, which may last for years and perhaps generations to come. A better name for this state of things would be coexistence with conflict."

It was upon this rationalization of the problem that the Party line was framed. For in 1938 Stalin, in his Communist decalogue, "Leninism," roundly affirmed: "We are living, not merely in a state, but in a system of states, and it is inconceivable that the Soviet republic should continue to exist interminably side by side with imperialist states. Ultimately, one or the other must conquer. Pending this development, a number of terrible clashes between the Soviet republic and the bourgeois states must inevitably occur."

Since that frank exposé of concepts and intentions was penned, develop-

ments in nuclear physics, on both sides of the Iron Curtain, have counseled certain modifications in the Soviet methods of conducting a conflict which the Kremlin still pursues with unabated zeal. As both parties have come to realize, in any all-out "hot" war the choice would lie between defeat and the race suicide entailed in the employment of major nuclear weapons.

The concept of a "shooting" war on any scale larger than the localized Korean conflict has yielded place to the active prosecution of that war of attrition, by propaganda, subornation, and subversion amongst the "uncommitted" peoples and extremist "labor" circles, which the Kremlin is currently pursuing with such unwearying tenacity and, withal, with such menacing success.

This, of course, conforms to the pattern of specious gestures of conciliation, with an undertow of threats, whose purpose Dimitri Manuilsky defined in the 'thirties in a speech so frankly revealing that it nearly cost him his job as professor of historical science. "War to the hilt between Communism and capitalism," he pronounced, "is inevitable. Today we are not strong enough to attack. Our *time will come within twenty or thirty years*. To win we shall need the element of surprise. The bourgeoisie will have to be put to sleep. We shall begin by launching the most spectacular peace movement on record. There will be electrifying overtures and unheard-of concessions. Stupid and decadent, our enemies will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we shall strike them with our clenched fist."

The implementation of such a technique of organized dissimulation gives every assurance that the Western leaders' appearance at a further Summit meeting will result in their yielding yet another line of defenses to the sapping and mining the Communists always busily engage in under cover of the flag of truce.

There need be no surprise at this. The Communists regard all negotiations around a table, not as an occasion at arriving at a reasonable settlement, mutually acceptable, but as an opportunity to establish *de jure* acceptance of a *de facto* situation brought about by the brutal exercise of power. Moreover, their technique of negotiation differs entirely from that practiced by the West. Their code is almost entirely Oriental in its unblushing employment of evasion, opportunism, "double talk" and downright mendacity to attain ends which only reveal their full malignant scope when the West has been hoodwinked into conceding them.

Only too faithfully they abide by the Leninist precept, that in negotiation with the West they are justified in having resort to "every kind of trick, cunning, illegal experiment, concealment, suppression of the truth, to conduct, at whatever cost, Communist work. From the point of view of Communist morality anything is ethical and moral which promotes the building of a Communist society. Everything hindering this is unethical and amoral"—a dogma considered so fundamental and abiding that it was repeated in a Moscow broadcast of 1955.

Stalin reaffirmed the general line of approach in the fifth volume of his "Problems of Leninism" (1947). For in this he wrote: "The tasks of the Party in foreign policy are first to utilize every contradiction and conflict amongst the surrounding capitalist groups and governments for the purpose of disintegrating imperialism; secondly, to spare no means to assist the national-liberal movement in the East; thirdly, to spare no means to assist the proletarian movement in the West; and lastly, to strengthen the Red Army."

And leopards do not change their spots.

If Khrushchev's visage is momentarily wreathed in simulated smiles of sweet reasonableness, this is an indication of a switch in technique rather than of a change of heart:

"When he shows as seeking quarter,
With paws like hands in prayer,
That is the time of peril—
The time of the Truce of the Bear."

The real voice of the up-to-the-minute creed of Communist imperialism was heard in October of 1959 when Josef Potocek pronounced over the broadcasting system Radio Prague: "Without

hatred, which is part of the class struggle against anyone who obstructs the achievement of truly human relations, it is impossible to build a new society or a new world. This task can only be performed by Communists."

Such sentiments hardly appear to offer a stable basis for a period of peaceful coexistence.

Furthermore, has the West's preoccupation with its hedonistic way of life obliterated all consciousness of the fact that, even while Communism maintains its Camp David leer, Communist imperialism is on the rampage in Tibet and Laos, is responsible for a new wave of police terrorization in Rumania, ordained the execution—after almost three years in jail—of thirty-one Hungarian Freedom Fighters, and is as busy seeking to reassert its influence over its cat's-paw in Cairo as it is active in stirring up trouble in Iraq and Iran—in close proximity to those Persian Gulf oilfields so essential to the West's continuing prosperity?

SURELY there must be a point beyond which the most politically myopic are forced to put the question: How can negotiations be usefully entered into when the entire foreign-relations system of one side denies the existence of objective moral truth, deliberately perverts the meaning of basic concepts, and revels in the perpetration of any sly trick that will weaken or discourage the delegates on the other side of the table?

The inescapable conclusion is that over the past few years the foreign policy of the West has been controlled by its tendency to go round and round in a vicious circle. The public, wrapped in its own affairs, has panted for a relaxation of political tension. In consequence, the politicians obediently emphasized everything conducive to such relaxation and flagitiously minimized anything pointing the other way. As a result, public expectation mounted higher and higher, and pressure for an accommodating attitude vis-à-vis the Kremlin forced the nations' representatives on a course that must be dangerous and so easily could be fatal.

It is not even as if the Western leaders would approach the conference table with the confidence and resolution bred of a united policy. While the American President—with one eye on the forthcoming election campaign—plunges after the British Prime Minister's optimistic bulk, De Gaulle languishes in his megalomaniac dream of foisting an invalid France on the world as the most virile force in Europe; while Adenauer ruefully recalls the sacrifices demanded of Czechoslovakia to bring about the worthless and degrading *détente* of 1938.

While the Kremlin may possess a very clear idea of the Western powers' wealth and material resources, it has been given few grounds upon which to base a proper appreciation of their latent quality of determination.

Coalition diplomacy is always difficult; against opponents as foxy as the Communists it is virtually impossible, since plain honesty of purpose—even if unmuddled—will always find itself outsmarted by the wiles native to unscrupulous cunning. Only a fool plays against loaded dice.

"Beyond the shadow of a doubt this country is the prime target of an endless, all-out offensive. The tenets of Marx and Engels and Lenin are as firm a part of the Communist doctrine as when they were announced. The Communists attack us on every front and by every tactic including threats, brigandage, and police actions.

"While the Soviet psychological and economic threats are most alarming, let me mention briefly the facet of the over-all danger that most directly concerns me—the military threat.

"In air and naval forces, the Soviets have more than 25,000 warplanes and about 450 submarines. In land forces, the Russians have 175 ready divisions, plus about 4 million men in the satellite and Red Chinese armies. These forces constitute tremendous military power. . . ."—From an article by Lieut. Gen. Arthur G. Trudeau, Chief of Army Research and Development, in the January-February 1960 issue of ORDNANCE Magazine.

A WORK which appeared in 1939 under the title "A Short Course in the Party History" laid it down that "there can be no such thing as friendship. There is only the Party, which is the Soviet Government, and its enemies; and that enmity should always be stimulated and increased except when important tactical reasons make advisable a temporary course to the contrary."

That seems clear enough in all conscience—as stark an example of the writing on the wall as could be looked for by the most exacting historical observer.

There remains the little question of morality. Is it to be accepted that the Western powers are so mortally scared of the consequences of championing elementary justice and decency that they are prepared meekly to compound with the mammon of unrighteousness? Is there no body of honest God-fearing men to recall and act upon the Charter of Human Rights and insist that the first item on any agreement arrived at with the Kremlin shall be the manumission of the unhappy millions in the satellite nations that are still held in bondage to the Communists?

If such a demand were to be rejected—which must be predicated—then let the Western world throw a *cordon sanitaire* about such nations and see how kindly they take to enforced isolation.

Appeasement, however euphemized, simply quadruples the dangers it seeks to avert. As that staunch friend of America, William Pitt, Earl of Chatham, was ever known to insist, "The boldest measures are the safest."

THEREAFTER, if the Russian people yearn to reestablish contact with the West—as we are constantly being told they do—then let it be known that their welcome into the comity of nations is assured once they have cleared out the Augean stable in the Kremlin and fumigated the ill odor in which the Muscovite people have elected to exist for the past forty-two years.

Frederick Huff Payne

In Memoriam

COLONEL Frederick Huff Payne, a charter national director of the American Ordnance Association and one of its most enthusiastic members, died at his native city, Greenfield, Mass., March 24, 1960. Throughout his long life—he was in his 84th year—his energies and his ideals were always built upon the need for adequate defense for the United States. He was especially concerned with the problems of industrial preparedness in which his guiding influence brought about a better understanding of the interdependence of our national defense, American science, and industry.

Colonel Payne, who maintained his commission in the Army Inactive Reserve, was Assistant Secretary of War in the Administration of President Herbert Hoover from 1930 to 1933, and brought to that office a broad background of industrial, financial, and military experience.

He was born in Greenfield, the son of Samuel Brewer Payne and Eva Carolyn Huff. He received his education in the Greenfield schools and became a state bank examiner in 1906. Later he was president of the Mechanics Trust Company of Boston. Commissioned a major in the Ordnance Reserve in 1918, he served as assistant chief of the Bridgeport Ordnance District and of the Bridgeport District Claims Board in the First World War.

In the postwar organization of the Bridgeport District, Colonel Payne became assistant chief, serving on a dollar-a-year basis continuously from 1919 to 1930. He resumed this status again at the termination of his service as the Assistant Secretary of War in 1933.

He was successively treasurer, vice-president, president, and chairman of the board of the Greenfield Tap and Die Corporation. Subsequently he was a partner of Tucker, Anthony and Company, investment bankers of New York and Boston. He was also a member of the boards of directors of several industrial and financial organizations.

During his tenure as the Assistant Secretary of War, the first Industrial Mobilization Plan ever adopted as national policy was presented to the Congress.

THE Crowell Medal of the American Ordnance Association was awarded to Colonel Payne in 1946 for distinguished ordnance service. He served faithfully as a member of the Association's board of directors without interruption since the Second World War. He was a past president of the Association's Hartford-Springfield Post and a member of the board of directors of the Post at the time of his death.

Zealous in his ideals, energetic in his actions, and loyal in his friendships, Colonel Payne possessed in rare measure the understanding and good nature which endeared him to all his colleagues and friends. The Ordnance Association owes him a debt of gratitude for his constant participation in the direction of its policies and their execution. So, too, are American industry and the Nation indebted to him for a degree of leadership which will have lasting beneficial effects.—L.A.C.

Science vs. Wisdom

With the enormously increasing amount of knowledge being unfolded in our laboratories we have great need for men of vision and wisdom who are able to unravel and interpret the scientific mumbo jumbo

IMPRESSED by a recent item in ORDNANCE magazine, one of our readers, an Ordnance captain overseas, wrote to tell the author, Col. George S. Brady, of attempts to interest electronics experts in solving the problem of interpretation of technological information and data after they have been obtained (see Colonel Brady's Materials Progress department—ORDNANCE, January-February 1960, p. 615).

Colonel Brady had said in his column that the spending of more and more money on research is not enough to keep us ahead in the technological race. It is a necessity, he told his readers, to develop better methods of coordinating, digesting, and disseminating the results of research.

The following reply of Colonel Brady to the young captain emphasizes the necessity for bringing forth men qualified to utilize broadly the results of technical research today and to report scientific findings in understandable language.

DEAR Captain:

I appreciate the interest expressed in your letter regarding my article, and it is encouraging to note that some of the younger technical officers do visualize the big problem that confronts us in digesting and coordinating the tremendous amount of new scientific and technical data that are increasingly unfolding in geometric progression.

You should not be discouraged that you "have failed to fire the proper people with the possibilities now available to us." I am glad to note that you consider yourself merely "bowed, but not defeated." History shows that every advance had to be fought for against the blindness and lethargy of those who resist change.

Col. George S. Brady, who wrote the accompanying letter, is a contributing editor of ORDNANCE *magazine and the author of its Materials Progress department. He is also a consulting engineer and a well-known authority in the field of materials. His "Materials Handbook" for many years has been a recognized source of information on this subject which has special import in today's specialized weapons technology.*

This problem of interpreting technical data for better use is really not new. It has merely become more intense and frustrating, and if we do not face it now we can become overwhelmed by it. As I stated in the article, the answer to the competition with Russia does not lie in spending more and more money for research but rather in a better utilization of what we develop in our laboratories.

About eighty years ago, when the industrial age was first getting into high gear, Matthew Arnold, the "Apostle of Culture" at Oxford, wrote: "The greatest men of culture are those who have had a passion for diffusing, for carrying from one end of society to the other, the best knowledge, the best ideas of their times; who have labored to divest knowledge of all that was harsh, uncouth, difficult, abstract, professional, exclusive—to humanize it and make it useful outside the clique of the cultivated and learned."

But electronic machines are "brains" only in their ability to store information and sift and assemble it rapidly. You cannot get anything out of the machine that is not put into it. Without competent men of broad analytical minds to digest and fragmentize the data into simple, generally understandable units to be fed into the machine, the "electronic brain" is of very limited use.

THUS, we have now a far greater need for these "great men of culture" than at the time of Arnold. I sometimes feel that even the manufacturers of the machines do not yet realize the great possibilities, especially the great need for a new type of professional man who can divest the data of all that is "abstract, professional, exclusive," and make them useful to the hundreds of thousands of nonscientist executives, engineers, and workers who have the job of producing goods and equipment in our factories.

At the annual meeting of the Society for Engineering Education last June, there was much discussion of the increasing difficulty of offering a curriculum in industrial materials. One college professor said that it is impossible now to cover the vast subject—that it is only possible to train specialists in the separate categories.

As far as I could see, nothing came

out of the discussions because they completely lost sight of the fact that a new type of interpretive mind must be developed, a mind with vision and imagination to see the over-all paths and not get lost in the detail of the specialists.

SO far, it seems that most of the electronic machines have been used for specialized purposes—accounting, mathematical calculations, etc. There is no complaint against this, but it is only a minor part of the job to be done. The big job is to make the scientific data more available and useful. You cannot expect scientists and technical experts to be the ones to handle the machines for this purpose.

Scientists in general operate in too narrow-minded a channel. There is an old saying: "You can always tell an expert, but you cannot tell him much." Recently, an old friend of mine, an 80-year old editor emeritus of a national magazine, wrote:

"Scientists have never been good at explaining themselves, and, frustrated by this, they tend to withdraw into the esoteric, refer to the public as laymen, and develop incomprehensible vocabularies from which they draw a naïve secret-society feeling of superiority."

To prove how true this is, one has only to talk to the scientists or read their reports. Not long ago I called up the Naval Ordnance Laboratory to inquire what the term "stoichiometric proportions" meant in one of their reports. After a 10-minute earful of prolix explanation I deduced that the coined secret-society scientific term simply meant "exact chemical proportions."

But a scientist would think it too plebian and beneath his dignity to say that he mixes materials in "exact chemical proportions." Apparently, complexity indicates professional wisdom, and he digs up some Greek and Latin to impress the "laymen." It is the same "naïve, secret-society feeling" that induces the African witch doctor to use mumbo jumbo.

Another early culturist, William Cowper, said that "knowledge is a rude unprofitable mass, the mere materials with which wisdom builds. Until smoothed and squared and fitted to its place, it does but encumber whom it seems to enrich. Knowledge is proud; wisdom is humble!"

Now, with the enormously increasing amount of knowledge being unfolded in our laboratories, we have a dire need for men of vision and wisdom who can unravel the scientific mumbo jumbo, digest and coordinate it, and make it more useful to industry at large.

We have heard much of Red spies stealing our secrets, but I think that is overestimated. They do not need spies for the purpose. I think that they are ahead of us in simplifying and utilizing scientific data which they can get from our scientific reports. I can cite case after case where they have put the expensive findings from our research into practical use ahead of us.

In a small way, ORDNANCE and other similar magazines are doing an interpretative job, but, as you know, the bigger job will have to be done by the electronic machines. However, most scientists are isolated on haughty plateaus of knowledge and are not willing to believe that the common "layman" is capable of understanding his work. To make the electronic machines most useful, we must develop a new type of professional man with the vision and wisdom to digest, interpret, and coordinate the scientific data.

I hope that you will continue to work with the electronic-machine people in getting that idea across. You will not find it easy because they themselves are a bit inclined to worship the scientists. And in your fight for recognition of your ideas you will make plenty of enemies among those who love to sit around tables and iron down all the conflicting opinions into a safe mediocrity which they call "calculated risk."

Some times and occasions require diplomacy, but battles are not won by diplomacy and calculated risks. Successes are the results of courage, daring, initiative in crises, strong wills to do. Battles are won by the Pattons, the Grants, the Rommels, the Jacksons, the Sheridans. Patton did not make himself loved at GHQ when he snapped back at an order to pull back and rest: "There are more tired generals than tired troops."

And Halleck and his staff, endlessly juggling "strategies" to find answers to all possibilities, did not like the brash Major General Grant who swept aside all their calculated-risk arguments and took his cigar out of his mouth long enough to say: "My book of strategy has only four words, 'When in doubt, fight.'"

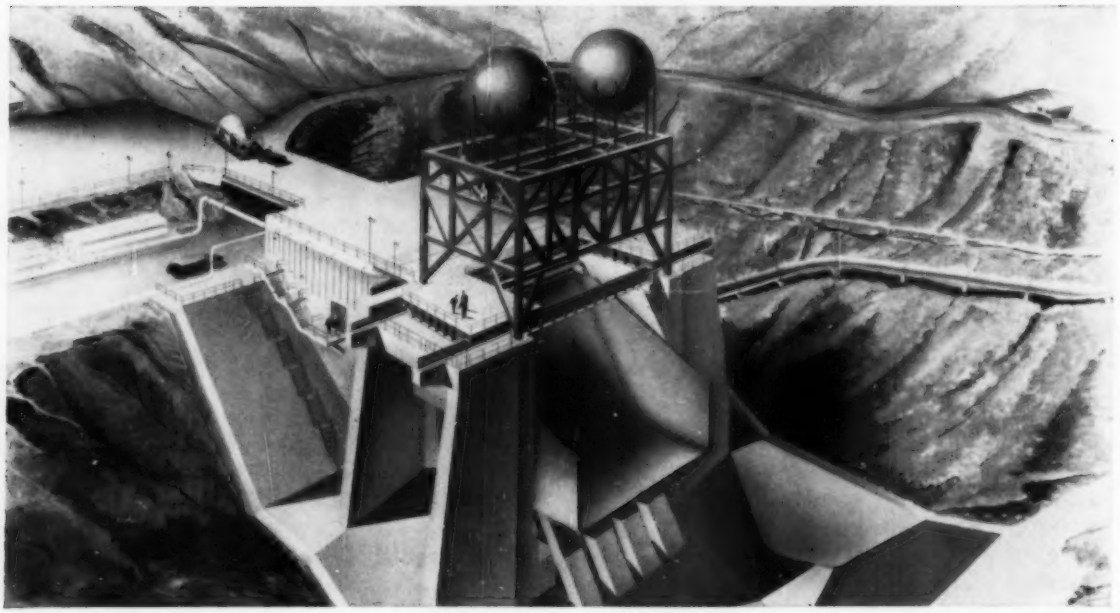
In your fight you may run the risk of being shot in the back by your own men, as was Jackson, or court-martialed, as was General Mitchell, but today General Jackson is among the immortals, General Mitchell's name is famous, and those who condemned him are unknowns. Men of science are hero-worshipped in this country today, and it will take courage to try to break down their Druidical hierarchy and prove that all their methods do not constitute the best exercise of reason.

BUT you will have good company in the struggle. I note in today's mail that Oxford has again taken up the fight for true culture. Professor Michael Polanyi, who was recently given the Lecomte Award for his human relations work, has been blasting the scientists as the "Sacred Cows." He says that there are "blatant absurdities in the scientific approach," and he wants to be rid of the "obscurantism of modern science" and strive for a "reformed scientific outlook."

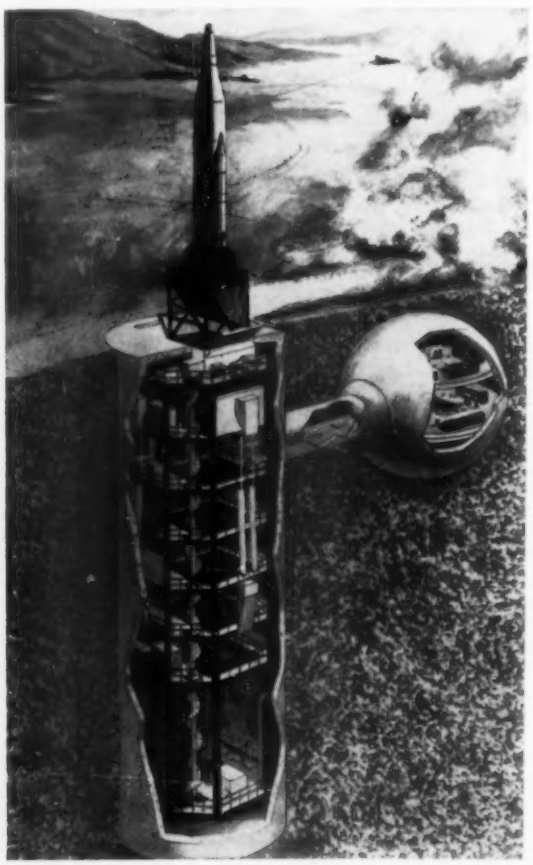
I am gratified to note that my deductions are quite in line with the reasoning of that eminent man.

I am sorry that at my advanced age I can take little part in assisting you in bringing about the necessary evolution, as you request. I first enlisted in 1905 when materials and equipment were simple, when our infantry company was equipped only with Krag rifles and a one-pounder "landing gun," and our field rations consisted of beans, "sowbelly," and hardtack. I have seen many changes and hope that I have done my share of fighting against stubborn inertia to effect those changes. It is now up to you of the younger generation to do the fighting. Gluck Auf!

New Missile Structures



The 6,000,000-pound-thrust rocket engine test stand shown in the drawing above is being constructed at Edwards Air Force Base, Calif., for use this fall. Below is an artist's conception of an underground silo emplacement for an Atlas ICBM with maintenance and fueling being done at left and at right the missile raised and engines ignited (Air Force photo).



Defense Highlights: Monthly Review and Outlook

• **Army Airlift Test.**—Airlift capability was tested on a large scale recently when the Military Air Transport Service lifted 21,000 Army troops and 11,000 tons of supplies to Puerto Rico in 15 days. This was exercise Big Slam, a check on the wartime capability of MATS and an effort to determine the long-range needs of the armed services' sadly neglected airlift.

Half of MATS craft remained on logistics overseas supply flights while the other half engaged in Big Slam with all crews on 8-hour instead of 5-hour shifts and maintenance men working 12 hours a day. This could not be a sustained operation as proved by the fact that most crews are leaving to recuperate while commercial airlines take over for two months a larger share of military air supply—about $7 million worth.

As a limited war test, most observers agreed it was inadequate because the average distance from initial loading points was only about 1,700 miles—considerably less than overseas flights where brush-fire wars could be expected. Also, fuel and spare parts were stored in Puerto Rico ahead of time—and then not under emergency conditions.

As a test of equipment, the aircraft performed well and with great reliability in spite of their general obsolesence. Nevertheless, aircraft industry observers, MATS leaders, and Army officers all hastened to point out how much faster equivalent loads could have been lifted with larger and faster turboprop cargo aircraft.

The trend in Congress seems to demand a modernization of our airlift. After it has digested the critique on this exercise, Congress will have to decide whether to allot large sums immediately to convert existing Boeing 707 or Douglas DC types to air transports or to direct a longer-range program to develop an all-purpose "freighter."

The exercise did nothing to clarify the uncertainty of the Strategic Army Corps as to how much airlift would be available in the face of the Strategic Air Command's reserve requirements or the needs of the Tactical Air Command. The latter force with its own troop carriers for short-range assault did not enter into Big Slam. Also available in a real emergency would be the 230 commercial aircraft of the Civil Air Reserve, although their effectiveness is of doubtful value.

• **Sealift Shortage.**—Our "sealift" inadequacies also have been presented to Congress by Vice Adm. R. E. Wilson, Deputy Chief of Naval Operations, Logistics. He reports that there is adequate shipping for limited war but a 22 per cent shortage in troop transports and a 6 per cent deficit in cargo types under present general war requirements. This includes allowances for casualties.

The available fleet is obsolescing rapidly with only about 13 out of 263 transports and 90 out of 2,400 cargo vessels being constructed with later than World War II designs.

• **The Guard on Guard.**—Thirty-six Nike Ajax batteries and six Nike Hercules batteries in Hawaii will be added to the National Guard's responsibilities. By June 30, 1961, the Guard will take over six areas in addition to the eleven it now controls. Regular Army personnel released will be transferred to Nike Hercules, Lacrosse, and Hawk battalions.

• **Space Center.**—The George C. Marshall Space Center is the new designation of that part of the Army Ordnance Missile Command turned over to the National Aeronautics and Space Administration. The scientists there under Dr. Wernher von Braun are now testing the 8-cluster engines for the Saturn booster in pairs, fours, and together. Launchings are anticipated as follows: one stage, 1961; two stages, 1962; three stages, late 1963 or early 1964.

• **Rocket Progress.**—The National Aeronautics and Space Administration in its first year and a half has not only adjusted to its expansion problems with new organizations and personnel but also maintained a broad research program. It has been concentrating especially on a variety of experiments for pumping hydrogen, oxygen, and nitrogen, both liquid and gaseous, for use in boosters and engines of future spacecraft.

Launching rockets have been improved steadily, the number of types reduced, and old ones phased out as research leads to improvements. In 1962 the last Atlas and Thor Deltas will be used with Scout, Atlas Agena-B, and Atlas Centaur taking over. Twenty-five to thirty major launchings yearly are in the NASA 10-year plan.

• **Space Medicine Men.**—In its latest move NASA has created an Office of Life Sciences with two objectives—to study the effect of space environment on live organisms and to do research in biomedical problems of man in space. Since practically all such work has been directed by the three military services there will probably be another demand for some of their medical personnel by NASA to build up the new office.

• **Nuclear Test Ban.**—Government officials directly responsible for the Nation's security are more alarmed than ever over the latest nuclear test ban proposals. They see no assurance of close surveillance and adequate safeguards on foreign experiments, with the result that our own capability will grow relatively less under an indefinite cessation without solid guarantees.

There is hope that the true Soviet attitude will be revealed when they are asked to cooperate in an underground test with a 19-kiloton explosion scheduled in a New Mexico salt mine in early 1961.

• **New Rubber-Tired Train.**—A gigantic rubber-tired land vehicle consisting of 13 cars with 10-foot-high tires, and stretching 560 feet in length, has gone into production at the R. G. LeTourneau plant in Longview, Tex. This train will aid the Army in carrying cargo to remote areas over rough terrain where roads are nonexistent.

• **Missile Carries Own Observer.**—Another Army "first" was the TV station carried by a Redstone ballistic missile launched at White Sands Missile Range, N. Mex., in mid-March.

Housed in a small capsule, the camera is ejected from the Redstone during flight and, while falling groundward, takes pictures of the impact point of the missile warhead and, subsequently, of damage done.

This miniature TV station enables a ground commander at a receiving station miles away to see the actual target damage by the missile. In this case pictures were transmitted seventy-five miles from the impact point.

• **Missile Notes.**—The Air Force Titan, with its successful flight on March 22nd, had a box score of seven successes, two partial successes, and two missiles lost at launching.

Dolphins, the operational scale models of the Polaris missile, are now being used in system checks and for training aboard missile submarines. They clear the water, fall back, and are then recovered.

A Nike Hercules missile recently was launched with a radar beacon, a Doppler transponder, and a blinking spotlight on a 50-mile trajectory in "Operation Precise" at White Sands Missile Range, N. Mex. This equipment enabled the Integrated Missile Range personnel to conduct a highly refined check of the accuracy of the range instrumentation.

Also at White Sands, the Army has fired another test model of the Nike Zeus antimissile missile. Launch, boost, separation, and sustainer operations were successful.

Two Lacrosse guided-missile battalions have reported for duty to our Army Forces in West Germany. They are part of the 5th Missile Battalion, 42nd Artillery, and the 4th Missile Battalion, 28th Artillery.

Closed-circuit TV instructions on missile operation and maintenance are being piped into classes at West Point, MIT, and the Royal Canadian Military Academy, Kingston, Ont. Programs originate at Huntsville, Ala.

The submarine HALIBUT was the first nuclear sub to fire a guided missile when it successfully launched a Regulus II near Oahu, Hawaii, late in March. The Regulus circled Niihau Island at 600 m.p.h. and was guided in to a landing at Bonham Air Force Base without damage.

• **Air Force Withdrawal.**—The U. S. Air Force withdrew quietly from its base at Ben Slimane, Morocco, a month ahead of schedule to keep out of technical disputes between Morocco and France. This was the first move to fulfill the agreement of last December between President Eisenhower and King Mohammed V for total U. S. military withdrawal from Morocco by 1963.

Ben Slimane is the smallest of five U. S. bases originally established there on land which was provided by French authorities in order to give us intermediate bomber bases from which to support our allies in Europe.

• **New Rifle Production.**—The new M14 Army rifle is rolling off the production line with the first issue going to the 101st Airborne Division—which won't be fully equipped until late this year. In the meantime, Gen. L. L. Lemnitzer, Army Chief of Staff, has presented the first M14 for Marine Corps use to Gen. David M. Shoup, their Commandant. Full-scale distribution to the Marines will not start until 1961.

The M14, accepted after many years of exhaustive tests, replaces the M1 adopted in 1936 which in turn followed the old Springfield caliber .30 introduced in 1903. The new rifle is slightly lighter than the M1, fires a 7.62-mm. cartridge, and uses a 20-round magazine.

Production is divided between Harrington & Richardson, Inc., and the Winchester-Western Division of Olin Mathieson Chemical Corporation, with a small lot under manufacture at the Army's Springfield Armory.

• **The Missile Fleet.**—The Navy's missile-launching fleet will total eleven cruisers by this fall. There are now six in service including the cruisers HELENA and LOS ANGELES that are fitted out to fire Regulus I surface-to-surface missiles. The five cruisers to be commissioned this year are LITTLE ROCK (CLG-4) and OKLAHOMA CITY (CLG-5) equipped with Talos surface-to-air missiles; SPRINGFIELD (CCG-7) and TOPEKA (CLG-8) with Terrier surface-to-air missiles; and LONG BEACH (CGN-9) to be armed with Terrier, Talos, and the Asroc ASW weapon.

The LONG BEACH, built from the keel up for its task, will be this Nation's first nuclear-powered surface ship with two twin Terrier launchers forward, and one Talos launcher aft. Navy officials also sought authority to design the LONG BEACH to give a future capability to launch the Polaris intermediate-range ballistic missile but were not allowed sufficient funds.

The other ships are conversions of World War II light cruisers and will retain two 6-inch-gun turrets forward. Three conversions in 1961 will mount Talos, Tartar, a new surface-to-air missile, and Asroc.

• **Subsurface Communications.**—A contract for $116,000 with the Air Force to conduct studies and experiments in subsurface propagation of electromagnetic waves has been awarded to Space Electronics Corporation, Glendale, Calif. Under contract with Rome Air Development Center, Griffiss Air Force Base, N. Y., the company will perform a general research program to determine feasibility of using electromagnetic wave propagation, having components deep within the crust of the earth for transmitting information.

Communication using this technique has been found feasible, and substantial verification of the theory for short ranges has been obtained.

Nuclear Policy for War and Peace

An Editorial

A STUDY bearing the above title has appeared recently in book form. It is of wide significance for a number of reasons. Foremost among these is the light it sheds upon one of the most momentous problems of our time; viz., to resume or to forego the testing of nuclear weapons.

There is much hysteria on the subject ranging from the powerfully organized propaganda setup to stop such testing to the well-reasoned dispassionate stand of those who believe that nuclear testing, particularly of the smaller weapons, should be carried forward without further loss of time.

The author of this book is well known and well qualified to counsel on so vital a subject. He is Thomas E. Murray, formerly a member of the Atomic Energy Commission, presently a special consultant to the Joint Congressional Committee on Atomic Energy. He is an engineer, an industrial executive who has achieved practical results, and the inventor of some two hundred devices in the electrical and welding fields. During World War II he directed the conversion of plants under his management to war production and was a leader in arbitrating labor disputes.

No visionary, and certainly the antithesis of the Hollywood characters who circulate petitions to quit nuclear testing for keeps, the author is a realist and—even more important—a moralist. The proper use of nuclear energy in war and peace rests squarely on realism and morality—as do most decisions affecting national security and individual conduct.

It is as refreshing as it is unusual to see a discussion of such fundamental importance based upon "the forgotten equation"—the relationship between national strategy and morality. Mr. Murray develops—and, we think, proves—that any strategy based upon massive retaliation against noncombatants is irrational and unmoral.

He recalls the Christian tradition of warfare, which is not that of radical pacifism nor yet that of swashbuckling militarism. It is rather the modern application of the biblical counsel: "When the strong man armed keepeth his court those things which he possesseth are in peace." The prevalent philosophy that would destroy civilization on the alleged grounds of saving it presents the world's best example of the blind leading the blind.

Many informed professionals hold, as Mr. Murray does, that we have gone too far already in the development and production of multimegaton bombs and that we can well afford to stop. Indeed, he goes further and would destroy these mighty destroyers—one of ours for one of the Communists—if dependence can be placed upon the Communist word. That time has not come yet and, in the nature of things, is not just over the horizon.

But the error of our ways, in Mr. Murray's view, is that we have boxed our armed forces into a corner by discontinuing nuclear testing of small weapons. Here is where the felony is being compounded with each passing hour. The development of small nuclear weapons for the battlefield is the crying need, and yet we have tied the hands of our soldiers, sailors, and airmen while an unconscionable adversary can secretly go ahead. It is this kind of tragedy that will weaken our defense posture beyond reclaim.

On this score the author states the case with precision and conviction:

"In our obsession with the goal of developing a capacity to deter massive nuclear aggression, we have, according to more than a few strategic authorities, simultaneously incurred an incapacity to fight the kind of war which is likely to occur in the future. By making the so-called 'ultimate weapon' the central instrument of our defense setup, we may indeed continue to deter a full-scale nuclear knockout attempt by the Communists.

"The Communists, who are hardheaded realists and seasoned practitioners of the international power game, appear no more anxious than we are to do anything which is almost certain to bury them under a pile of rubble. But the fact that we deter an all-out nuclear war does not mean that we shall be delivered permanently from the scourge of war.

"In fact, since the advent of the Atomic Age at least a dozen international or civil wars of one sort or another have been fought in Europe, Asia, and Africa, and the great majority of them have been either instigated or exacerbated by the Communists. In an unstable and fast-changing international environment, situations will almost certainly arise in the future where the United States will have to intervene and apply counterforce."

THERE are many other facets of nuclear-energy application strikingly brought out in the pages of Mr. Murray's analysis. But transcending them all at the moment is the necessity for our continuing to test small nuclear weapons. To delay is simply to increase the peril.

The "strategic imperative. . . . is that the United States concentrate on the development of nuclear weapons in the lower order of destructiveness. We must equip ourselves with a wide range of weapons in this category in order to strengthen our capabilities for waging in a civilized fashion every manner of warfare into which we might be forced. This means that we should create a balanced stockpile, with emphasis henceforth on the manufacture of atomic weapons which lend themselves to discriminating use. Our need is for tens of thousands of such weapons."

The editors of ORDNANCE chose Mr. Murray's book as their selection for the month of April and so recommend it to all members of the Association. It is "Nuclear Policy for War and Peace," published by the World Publishing Company, Cleveland, Ohio. It is well worthy of detailed study by every student of our national security.

ASSOCIATION AFFAIRS

Chattanooga Chapter Sponsors Clinic On Navy Research And Development

A Navy research and development clinic was held in Chattanooga on February 25th under the auspices of the local A.O.A. Chapter. Chapter President Harold F. Torok was general chairman for all arrangements and presided at the day-long meeting. He was assisted by representatives from the University of Chattanooga and the Chamber of Commerce. The Navy was represented by a high-powered assembly lead by Hon. C. P. Milne, Assistant Secretary of the Navy for Material.

The clinic, held in the university's Hunter Hall, was welcomed by Dr. LeRoy A. Martin, president of the University of Chattanooga who also introduced the principal Navy guest, Secretary Milne. The Secretary in discussing the management of Navy programs said:

"In a time when we are engaged in a race for improved weapons it is of primary importance to the Nation that we manage our research and development program so as to obtain these weapons with minimum delay. We must conserve skilled scientific and technical manpower." He also praised the cooperation of industry and the colleges in the upper Tennessee Valley region.

Rear Adm. Rawson Bennett, Chief of Naval Research, stressed the increasing importance of oceanographic research in talking about some of the accomplishments of his researchers and future programs. Capt. F. A. Allis, U.S.N., next explained how small business organizations could participate in the Navy's research and development projects.

The morning session closed with a preview of an excellent Navy film on the Lebanon incident entitled "Summer Interlude."

Vice Adm. John T. Hayward, Deputy Chief of Naval Operations, Development, was guest speaker at a luncheon in the Read House attended by all Clinic participants. Mr. Torok called on Dr. James L. Fowle, pastor of the First Presbyterian Church, for the invocation and introduced the head table guests.

Admiral Hayward was introduced by Lou J. Williams, president of the Chattanooga Chamber of Commerce. The admiral spoke on the "Navy's Industrial Research and Development Partners" using examples from the Polaris weapon systems program as an indication of the close cooperation that must prevail between industry and the services to accomplish projects of such vast extent.

In the afternoon, five panels composed of the Navy's key officers and engineers held a classified session to discuss specific problems in their particular field.

Dr. Howard W. Gilbert, assistant to director, Material Division, Bureau of Naval Weapons, chairmanned the first panel which was on metallurgy. The succeeding panel topics and their chairmen were: Metals Fabrication and Machinery, Comdr. Earl C. Vicars, Bureau of Ships; Electronics and Instrumentation, Louis Schlesinger, Bureau of Naval Weapons; Ceramics and Polymers, Elliot A. Bukzin, Bureau of Ships; and Food Equipment and Textiles, Lieut. Comdr. John J. Anderson, Navy Supply Research and Development Facility, Bayonne, N. J.

On each panel were three or four experts who discussed a special feature of such problems as "Refractory and Nuclear Shielding Materials," "Solid State Electronics," "Fabrication of Deep-Diving Submarines," and "Need for Ceramic Thermal Protection Systems."

In the evening all the Navy representatives and panel members were guests of the Tennessee Society of Professional Engineers at a dinner in the Hotel Patten. Secretary Milne, the guest speaker, was introduced by the Hon. P. R. Olgiati, Mayor of Chattanooga.

At Navy research and development clinic sponsored by the Chattanooga Chapter were, seated left to right: Hon. C. P. Milne, Assistant Navy Secretary for Material; Dr. LeRoy A. Martin, president, University of Chattanooga; Rear Adm. Rawson Bennett, Chief of Naval Research; Comdr. H. P. Dunlap. Standing, left to right: Maj. Gen. E. P. Mechling, A.O.A. Headquarters; H. F. Torok, Chapter chairman; Vice Adm. John T. Hayward, Deputy Chief of Naval Operations, Development, principal luncheon speaker; and Lou J. Williams, president of the Chattanooga Chamber of Commerce.

Drafting Section Of Production Techniques Division Draws Up Statement Of Its Purposes

The Drafting Section, Production Techniques Division, has drawn up a statement of its purposes. According to W. W. Thomas, chairman, Radio Corporation of America, Moorestown, N. J., the Section has been formed to provide to the military a group of experienced and responsible drafting administrators from industry to assist in the formulation of military requirements in the general area of engineering documentation and drafting administration.

While the primary purpose is one of service to the Department of Defense, there is unquestionably a secondary benefit as the participants gain a greater professional insight into the needs of Government and the interpretation of military specifications. Members of the Section participate as individuals rather than as representatives of their companies.

Effort may be directed to any phase of drafting and is not limited to requests from the military. Once a subsection has been established to study a problem, participation is completely voluntary. Thus, only experts with a sincere interest in the project are brought together to work on it. Every effort is made to cooperate with other technical and industrial associations. Formal meetings of the Drafting Section include complete status reports.

Meetings of the entire Drafting Section are held twice each year and consist of three basic elements: (1) Status report of all subsections where progress is taking place on specific problems; (2) Talks or technical papers on matters related to engineering design disclosure and administration thereof; and (3) An interchange of information on an informal basis.

Surface Preservation Section Holds Meeting At Watervliet Arsenal, N. Y.

The twenty-seventh meeting of the Surface Preservation Section, Production Techniques Division, was held at Watervliet Arsenal, the Army's gun design and procurement center, on March 15th and 16th with Section Chairman Max B. Roosa, Parker Rust Proof Company, Detroit, Mich., presiding.

Col. Walter M. Tisdale, arsenal commanding officer, welcomed the forty members attending and introduced Maj. Gen. Edward P. Mechling, director, technical operations, A.O.A. Headquarters, Washington, D. C., and Col. J. M. Gruitch, ACF Industries, Inc., New York, N. Y., chairman of the Production Techniques Division.

The opening day's activities included the presentation of the following papers: "Designing for Long Service," by Dr. John A. Stevens, Dow Metal Products Company, Midland, Mich.; "Problems in Reconditioning Guided Missiles and Electronic Equipment Caused by Corrosion," by Paul Tunnhof, Letterkenny Ordnance Depot, Pa.; "Some Specific Corrosion Problems in Production of Missile Components," by Harry L. Ammlung, Aberdeen Proving Ground, Md.; "New Developments in Fluid Bed Applications," by Lloyd O. Gilber, Rock Island Arsenal, Ill.; "The Effect of Surface Preparation on Filoform Corrosion," by James I. Maurer, Parker Rust Proof Company, Detroit, Mich.; and "Phosphate and Conversion Coating, an ad hoc Committee Report," by E. A. Stockbower, Amchem Products, Inc., Ambler, Pa.

The afternoon session was concluded by a discussion of the "Future Program of the Surface Preservation Section," by Mr. Roosa and Henry Handler, Special Assistant for Industrial Relations, Office, Chief of Ordnance, Washington, D. C.

Weapons systems managerships and how they operate within Ordnance was the subject of a talk by Brig. Gen. John Cave, Assistant Chief of Ordnance for Program Coordination, Washington, D. C., guest speaker at the dinner meeting at the Troy Country Club on March 15th.

Final papers of the meeting were presented the following morning, and Lieut. Col. Harold V. Mackey, chief of the Arsenal's Research and Engineering Division, discussed that unit's current activities. Robert H. Hill, chief of the Chemical Processes Section, and conference coordinator, spoke on "Surface Finish Problems in Cannon Manufacture."

Mr. Hill also arranged a tour which included the physical science, metal-finishing and mechanical-test laboratories; fabrication and assembly facilities; and cold-working, heat-treat, magnaflux-testing and chrome-plating areas.

Members of the Surface Preservation Section, A.O.A. Production Techniques Division, during their meeting at Watervliet Arsenal, Watervliet, N. Y. (Army photo).

New Officers And Directors Are Elected At Meeting Of Texas Post In Houston

At the annual meeting of the Texas Post on February 10th at the Houston Club, Houston, Tex., new officers and directors were inducted and Brig. Gen. A. H. Schwichtenberg, U.S.A.F. (Medical Corps, Ret.), spoke on "Human Requirements for Space Navigation."

The general, who is now head of the Department of Aviation and Space Medicine, Lovelace Foundation for Medical Education and Research, served for thirty years in the Army Medical Corps and the Air Force Medical Corps. He discussed in interesting detail the progress in preparing the equipment and the men—and readying them for space flight.

The new directors of the Post are: R. O. Wynn, ACF Industries, Inc.; L. V. Dolan, Dolan Industrial Sales; and J. M. Forsythe, Forsythe Engineering Company. The officers are: F. G. Huber, president; C. H. Bone, vice-president; and H. C. Dill, secretary-treasurer.

Electronic Components Unit Meets With Advisory Group, Department Of Defense

The Electronics Components Section, A.O.A. Electronics Division, met with the Advisory Group on Electronic Parts, Department of Defense, at the Group's secretariat in Philadelphia, Pa., on January 13, 1960. Section Chairman P. S. Darnell, Bell Telephone Laboratories, Inc., Whippany, N. J., who is also a member of the AGEP, arranged the meeting to inform the Section members of the Group's activities.

Thirteen Section members observed the AGEP meeting which began with three technical reports. Jesse Marsten, chairman of the AGEP Working Group on Resistors, described the research and development program on resistive devices under Group study. He particularly emphasized the need for increased fundamental research on thin films for electronic parts. Dr. R. M. Soria, chairman of the AGEP Working Group on Transmission Lines, reviewed the Group activities in 1959 on such matériel as waveguides, coaxial lines, and strip lines. Dr. Soria also stressed the need for increased research on microwave transmission.

N. G. Doctor, Diamond Ordnance Fuze Laboratories, presented an illustrated lecture on the DOFL microelectronics program, emphasizing that microminiaturization is greatly reducing weights and volumes of electronic parts. Discussion

thereafter concerned the many activities of the AGEP.

The following day the Section conducted its own meeting to discuss how it could improve assistance furnished to the services. It was agreed that stronger liaison through joint meetings is desirable. Furthermore, it is believed that the strongest assistance can be rendered by advising of channels to solutions rather than by specific problem solutions which are usually beyond the scope of the Section.

Albuquerque Post Presents Scholarship Award During Meeting At Sandia Base

The Albuquerque Post held its winter stag meeting at the Sandia Base Officers' Club on Wednesday, February 17th. A feature of the meeting was the presentation by Post President J. J. O'Connell of the first $100 scholarship award to Raymond L. Lent, a University of New Mexico student and member of the Air R.O.T.C.

After the presentation and a brief business session, Mr. O'Connell introduced the principal speaker, Eaton H. Draper, director of systems development of the Sandia Corporation. In discussing "Shifts in Atomic Weapons Development," Mr. Draper pointed out that recent advancements in ordnance engineering have resulted in vastly improved nuclear weapons from the standpoint of reliability and simplicity. He gave examples of the simplification of weapons systems checkout routines where by a few quick checks an aircraft pilot is assured of the same reliability previously obtained only by long preparation and hours of checking.

Among the continuing engineering problems he cited were: (1) the increasingly severe environments presented by new weapons systems; (2) requirements for further miniaturization; (3) achievement of the ideal balance between operational safety and reliability and (4) continued simplification of stockpiled weapons.

General Ankenbrandt Holds Meeting Of Electronics Division Executive Board

The new chairman of the Electronics Division, Maj. Gen. F. L. Ankenbrandt, U.S.A.F. (Ret.), Radio Corporation of America, Camden, N. J., conducted a meeting of the Division Executive Board in Philadelphia, Pa., on January 15th. The meeting was called to discuss past activities, current projects and plans, and possible future actions that would most aptly contribute to the Division mission.

Particular attention was devoted to the need of avoiding duplication of the efforts of the many other electronics groups. Other important subjects were the staffing of the Sections and even the basic organization of the Sections for most effective performance. Because of the urgency of the staffing problem it was decided to table reorganization projects at this time. Subsequent discussion centered upon the next Division meeting, now projected for the fall of 1960 at the Pacific Missile Range.

Board members present included General Ankenbrandt; Col. H. G. Messer, General Electric Company, Syracuse, N. Y., Deputy Chairman; H. J. Schrader, RCA, Secretary; M. C. Batsel, RCA, Camden, N. J.; P. S. Darnell, Bell Telephone Laboratories, Inc., Whippany, N. J.; J. D. Woodward, also of RCA, representing Dr. S. W. Herwald, Westinghouse Electric Corporation, Pittsburgh, Pa.; J. M. Pearce, Martin Company, Baltimore, Md.; G. W. Cain, Frankford Arsenal, Philadelphia, Pa.; Henry Handler, Office, Chief of Ordnance, Washington, D. C.

Col. H. C. Thayer, U.S.A. (Ret.), Washington, D. C., represented the staff director for technical operations, A.O.A. Headquarters.

Underwater Ordnance Group Meets At Naval Mine Engineering Facility

The U. S. Naval Mine Engineering Facility, Yorktown, Va., was host to the Steering Committee of the Mine Section, Underwater Ordnance Division, for its meeting on January 27th. Section Secretary R. W. Robbins, DuKane Corporation, St. Charles, Ill., conducted the meeting in the absence of Chairman J. McW. Stone, also of the DuKane Corporation, and Deputy Chairman Dr. R. H. Whitehead, Scott & Williams, Inc., Laconia, N. H.

The first report presented was "Mine Material Reinspection," submitted by the ad hoc committee consisting of G. C. Throner, Aerojet-General Corporation, Azusa, Calif., and W. S. Leitch, Bendix Aviation Corporation, North Hollywood, Calif. A salient section of the report noted NMEF attempts to obtain improved production by (1) informing contractors of the function of the product and (2) obtaining feedback of engineering data from the contractor.

The Test Set Subsection presented the draft of a final report on testing and calibration procedures wherein a proven procedure used by a major corporation was outlined. C. A. Macris, Joliet, Ill., spoke for the subsection. Subject to some minor modifications, the report was accepted and approved for printing and submission to NMEF.

F. D. Friedlein, Charles T. Brandt, Inc., Baltimore, Md., submitted a progress report from the Case Materials Subsection. The report stressed the need for stronger liaison with the Materials Division to assure the best possible answers to this continuing problem.

For NMEF, the first speaker was J. V. Koman, who discussed the "Technical Publications Problem." His excellent presentation illustrated the need for the greatly improved readability of technical manuals. W. M. Pettit, Jr., reported on the progress of the refrigeration tests of clock delay mechanisms.

At Mine Section meeting, Yorktown, Va., were, seated left to right: A. H. Sellman, Bureau of Naval Weapons; H. A. Miller, Naval Mine Engineering Facility; F. D. Friedlein, Charles T. Brandt, Inc.; Comdr. T. R. Fonik, Naval Weapons Station, Yorktown; R. W. Robbins, DuKane Corporation, St. Charles, Ill.; T. J. Grady, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.; C. A. Macris, Joliet, Ill.; Dr. A. H. Lamb, Curtiss-Wright Corporation, Carlstadt, N. J. Standing, left to right: W. M. Pettit, Jr., Naval Mine Engineering Facility; Col. H. C. Thayer, A.O.A. Headquarters; H. M. DeWald, John Machek, Jr., T. B. McConnell, A. J. Friedhaber, and J. V. Koman, all of NMEF; Lieut. Comdr. G. T. Ragon, NWS; and N. Lewis, NMEF.

The universal problem of quality production by alternate producers was the subject of John Machek, Jr. Product redesign was suggested as a possible solution, but the time factor dictated a solution in the manufacturing process area for current production.

The subject, "Cold Flow of Diaphragms," was presented by T. B. McConnel, who also described recent NMEF work in this area.

The time schedule prevented discussion of the problems of mine batteries and of value engineering which were deferred until the next meeting when they could be more completely evaluated.

"Air Defense Of The Fleet" Is Subject Of Interesting San Diego Post Display

"Air Defense of the Fleet" was the central theme of the San Diego Post display during National Engineers' week in Southern California.

A special committee led by Capt. Harry C. Maynard, U.S.N., Operational Development Force, worked long hours to perfect an eye-catching array of models that exemplified Naval air defense at sea as well as a presentation of A.O.A. items that pointed up the Association's major function of seeking better ordnance by providing a talented advisory link between science and industry and the three services.

On the backdrop of the display were the A.O.A. banner and the new United States Navy flag, shown for the first time on the West Coast. The center of attraction was a 15-foot model of the nuclear-powered missile cruiser LONG BEACH (CGN 9) loaned by the Navy Electronics Laboratory. A full-sized Sparrow III missile was on exhibit, and models of all Navy missiles, and the ships and planes that launch them filled the tables.

Shown above are some of the members of a special committee of the San Diego Post who helped plan and man a special A.O.A. display. Left to right they are: A. L. Bergtold, U. S. Naval Reserve (Ret.); Calvin P. Owen, Post vice-president; Curtis Bates, Ryan Aeronautical; Capt. Harry C. Maynard, U.S.N., Operational Developmental Force; Thyrsis B. Field, Post president; Lieut. Comdr. W. H. Woodson, U.S.N.; and George B. Swanson, Post secretary. Theme was "Air Defense of the Fleet."

The booth was manned continuously by officials and members of the Post who aroused the interest of many visitors in the aims of the A.O.A. and enlisted a number of new members in the ranks of the Association.

Post officials who served with Capt. Maynard on the committee were: Thyrsis B. Field, Lieut. Comdr. W. H. Woodson, Calvin P. Owen, George B. Swanson, and A. L. Bergtold.

Welding Section Meeting Features Panels From Military Installations

A large turnout of more than one hundred members and guests of the Welding Section, Production Techniques Division, set the stage for a winter meeting held at Watertown Arsenal, Mass.

The novel meeting plan allotted time to several military installations with representatives of each speaking briefly on some phase of their installation's work and problems.

Frankford Arsenal led off with Harry Schwartzbart describing "Brazing of High-Temperature and Heat-Resistant Material." Andrew Pocalyco, Aeroprojects, Inc., West Chester, Pa., continued with "New Advancements in Ultrasonic Welding," a paper prepared by J. Byron Jones who was unable to attend. Problems of Frankford Arsenal were then presented for discussion by Frank W. Hussey.

The Watervliet Arsenal session opened with Louis Chevaney's "Development of Suitable Techniques for Projection Welding." Richard Lewis then led the discussion of Watervliet problems.

W. A. Wilson, Army Ballistic Missile Agency, Redstone Arsenal, Ala., began the session of that organization with "Welding of Aluminum Alloys in Missile Applications." Robert Hoppes followed with his paper, "Development of Tooling Criteria for Automatic Fusion Welding." Mr. Wilson returned with R. J. Schwinghamer to present, "Use of Ultrasonics for Control of Weld Quality in Aluminum Alloys," after which Mr. Wilson monitored the discussion of ABMA problems.

The afternoon session ended with a presentation by the host, Watertown Arsenal. C. E. Hartbower started with "Production Methods for Welding Titanium Alloys." W. P. Hatch then discussed, "Current Status of Weldability Testing." Mr. Hartbower presented, "Advancing the Technology of Welding High-Strength Sheet Materials," and then led the discussion of problems at Watertown.

The dinner session featured a speech by Brig. Gen. O. E. Hurlbut, commanding general, Ordnance Weapons Command, Rock Island Arsenal, Ill. An unscheduled and unexpected dividend came when C. E. Jackson, Linde Company, Newark, N. J., showed picture slides and informally described his experiences on an industrial visit to the U.S.S.R. He also made observations on technical and sociological progress in Russia.

The following morning's session was devoted to the Ordnance Tank-Automotive Command. Z. J. Fabrykowski began with "Ferritic Welding of Armor." B. A. Schevo then presented the Command problems for discussion. The industry picture, entitled "Industry Guideposts—Past, Present, Future," was depicted by Mr. Jackson, Jesse S. Sohn, Curtiss-Wright Corporation, Wood-Ridge, N. J., and J. H. Berryman, Air Reduction Company, New York, N. Y.

After a brief round-table discussion and summation by Mr. Ingram, the meeting adjourned for lunch and a tour of the welding facilities of the arsenal where members were enabled to inspect welding processes and diverse weldments in process and completed.

General Gavin Is Guest Of Honor At Annual Dinner Of Los Angeles Post

Lieut. Gen. James M. Gavin, former Army Research Chief, was guest of honor and principal speaker at the annual dinner meeting of the Los Angeles Post held in February in the Grand Ballroom of the Beverly Hilton Hotel, Los Angeles. All the traditional formality of Association meetings was brought into play in special tribute to General Gavin who received a great ovation from the many hundreds of members present. The occasion was also the twenty-fourth annual meeting of the Post which was established in 1936.

C. C. Gabrielson, chairman of the board of directors of the Post, presided, and Aubrey E. Austin, Post president, acted as toastmaster. The invocation by Lieut. Col. Emanuel Carlsen, chaplain at Fort MacArthur, Calif., was followed by the Pledge of Allegiance.

Mr. Austin introduced the guests at the head table and then presented a testimonial booklet to Samuel K. Rindge to commemorate his twenty-four years of service as Post treasurer and his forty years as a member of the Association.

General Gavin, now president of Arthur D. Little, Inc., Boston, and an outstanding speaker, gave an address that held the audience spellbound. He discussed his philosophy of the interplay of research and national defense and also the need to take optimum advantage of the best scientific and technical personnel in future planning.

Guests at the speakers' table were: Capt. and Mrs. Roland L. Wilson, U.S.N.; Col. Daniel A. Cooper, U.S.A.F.; Mr. and Mrs. Frank Mayer; Mr. and Mrs. Robert W. Reniers; Lieut. Col. and Mrs. Fancher K. Whitburn, U.S.A.; Mr. and Mrs. Aubrey E. Austin, Jr.; General Gavin; Mr. and Mrs. Gabrielson; Mr. and Mrs. Thomas V. Jones; Mr. Rindge; Colonel Carlsen; and Robert C. Geffs.

Lieut. Gen. James M. Gavin

General Schomburg Addresses Meeting Of Tennessee Valley Post At Huntsville

Maj. Gen. August Schomburg, Commanding General, Army Ordnance Missile Command, was honor guest at the Tennessee Valley Post winter meeting a few weeks after he assumed his new command, and a large crowd of members and guests packed the Huntsville (Ala.) Community Center to welcome him.

Post President Robert W. Cuthill introduced Robert F. Mello, personnel director, Army Ordnance Missile Command, the toastmaster for the occasion. After the invocation by the Rev. A. J. Yunker, Sr., the Hon. R. B. Searcy, Mayor of Huntsville and an enthusiastic supporter of the Army missile men, welcomed the guests.

At the brief business meeting, J. Allen Muller reported for the nominating committee on the new slate of officers which was then accepted unanimously, following which the officers, led by the new president, Milton K. Cummings, president of Brown Engineering Company, were introduced by Maj. Gen. E. P. Mechling, from A.O.A. headquarters, and Mr. Cummings took over the gavel.

Maj. Gen. J. A. Barclay, Commanding General, Army Ballistic Missile Agency, introduced General Schomburg who captivated the audience with a splendid demonstration of new developments in Army missilery and other research programs. Among the startling revelations were several examples of reductions in the size of radios and other electronic devices by microminiaturization of components. The general also did some tricks with infrared devices and exhibited on stage the old and new checkout gear for the Honest John missile. The new equipment requires only a few minutes' adjustment of three dials whereas the older apparatus was a complex of computers and instruments that needed a long series of manipulations.

The other new Post officers and directors are: Vice-Presidents D. H. Newby, NASA; A. A. Demetrious, Northrop Corporation; and Col. W. M. Talbot, Chrysler Corporation. M. C. Duke, Reynolds Metals Company, Sheffield, Alabama, is the national Council representative, and the new directors are: R. W. Washburn, Southern Associated Engineers; J. W. Wiggins, Thiokol Chemical Corporation; J. A. Muller, ABMA; M. J. Groat, AOMC; Karl Woltersdorf, Huntsville Utilities; Walter Wiesman, ABMA; T. D. Johnson, North Alabama Associates; Paul Shaeppi, Army Rocket and Guided Missile Agency; R. A. Harrison, IBM Corporation; J. R. Abbott, Lockheed Aircraft Corporation; L. G. Dawson, P. R. Mallory Company; and Dr. Ralph E. Swann, ARGMA.

Special Liaison Committees Of The Armed Services Meet With A.O.A. Staff Members

A series of meetings of the Special Liaison Committees of the three armed services and members of the staff of the Headquarters of the Association were held in January and February. The purpose of the meetings was primarily to improve the quality and quantity of assistance rendered to the services by the Association.

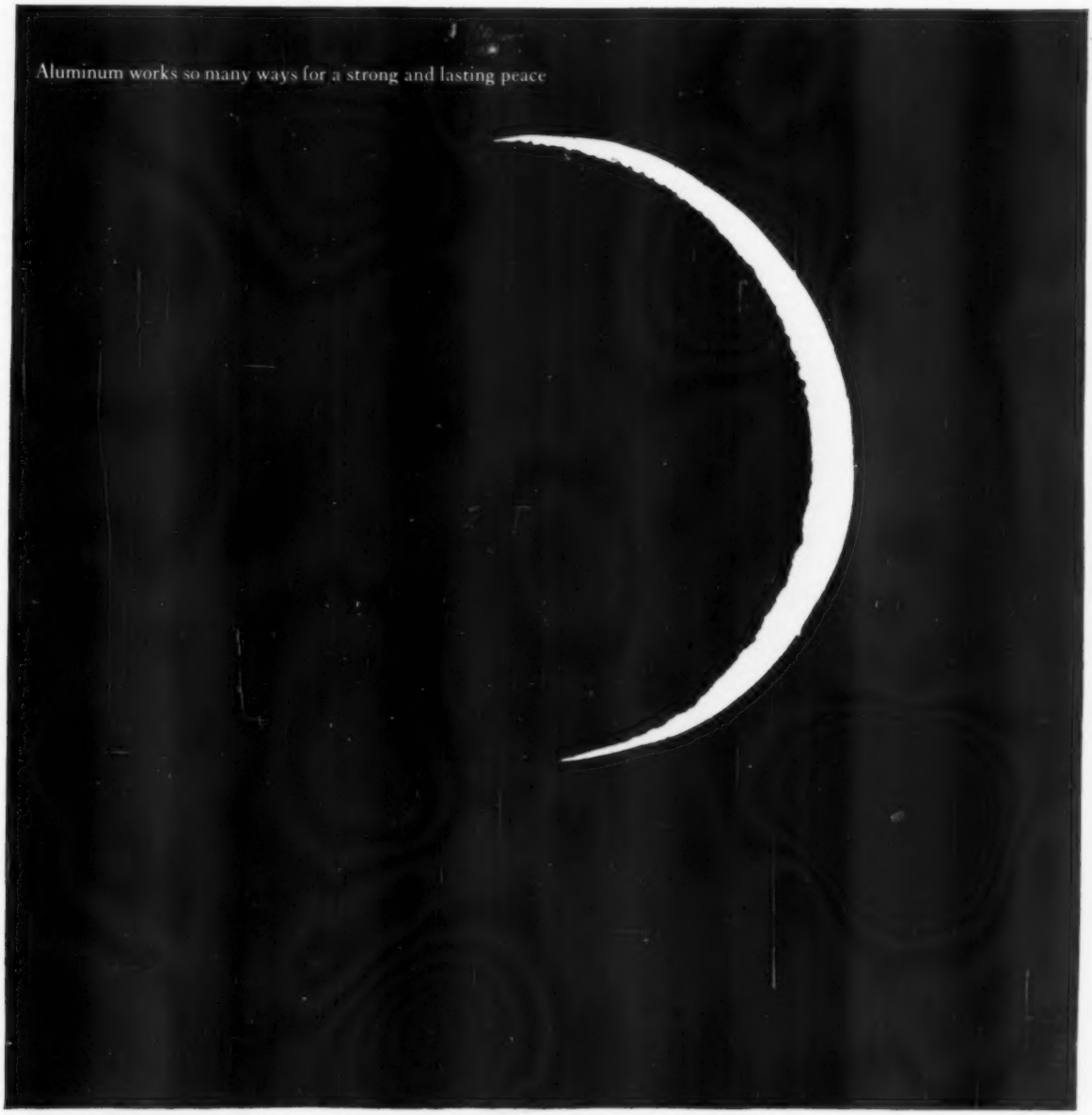
The mission of the Association was restated and amplified for newly assigned members of the three committees. Discussion then focused upon the role of the Liaison Committee and its fundamental position in assuring optimum coordination of the services and the Association.

Specific liaison problems were reviewed, and suggestions offered to improve the earlier fine relations that have existed between the service agencies and the Association. Two basic problems analyzed were those of accurate definition of problems by the services and the submission of timely recommendations by the Association.

Special Liaison Committee members present to represent the Army Ordnance Corps were Maj. Gen. N. M. Lynde, Chief of Field Service; Brig. Gen. Gunnar Carlson, Chief, Industrial Division; Brig. Gen. John Cave, Assistant Chief of Ordnance; Brig. Gen. Chet Clark, Office, Chief of Ordnance; Col. Robert Peters, Executive Office, Office, Chief of Army Ordnance; and Henry Handler, Office, Chief of Army Ordnance.

The discussion with Navy representatives also included relationships with the Bureau of Naval Weapons, successor to the Bureau of Ordnance and the Bureau of Aeronautics. Navy members attending from the Bureau of Naval Weapons were:

(*Continued on p. 896*)



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Rear Adm. C. T. Booth, Assistant Chief for Program Management, chairman; Capt. E. A. Ruckner, Assistant Chief for Research, Development, Test, and Evaluation; Capt. H. N. Larson, Executive Director, Office of Assistant Chief for Production and Quality Control; Capt. F. A. Chenault, Deputy Director, Special Projects Office; Capt. J. A. Pridmore, Executive Assistant and Security Officer, Office of Assistant Chief for Fleet Readiness; Comdr. Charles Helme, Executive Assistant, Office of the Chief of Bureau of Naval Weapons; and F. M. Gloekler, Assistant Research and Engineering Officer, who is secretary of the Navy Liaison Committee.

Plans for the 42nd Annual Meeting of the Association at Wright-Patterson Air Force Base on May 5th received much attention at the meeting with Air Force members of the Committee. Members attending included Maj. Gen. V. R. Haugen, Director of Development Planning, Office, Deputy Chief of Staff, Development; Maj. Gen. C. J. Bondley, Jr., Headquarters, U.S.A.F.; Gen. B. W. Chidlaw, vice-president, Thompson Ramo Wooldridge Inc., Cleveland, Ohio; Col. Paul M. Butman, Air Research and Development Command; Col. E. V. Conkling, Directorate of Research and Development, Office, Deputy Chief of Staff, Development; Col. J. E. Davoli, Office, Deputy Chief of Staff, Matériel; Col. R. T. Fincke, Headquarters, U. S. Air Force; Col. L. E. Johnson, Deputy Director, Logistics Plans, Office, Deputy Chief of Staff, Matériel; Jesse Hadley, representing the Bendix Corporation, Washington, D. C.; and Cliff Roberts, representing the Boeing Aircraft Company, Washington, D. C.

Yankee Post Holds Seminar And Dinner At Cambridge Research Center, Mass.

The Yankee Post winter meeting program covered a wide field of interests when members assembled at the Air Force Cambridge Research Center, Bedford, Mass., on Thursday, February 25th.

In the early afternoon at the Hanscom Air Force Base Theater a seminar was conducted by industrial leaders who presented their experience in team contracting for Army Ordnance. The speakers were: James P. W. Davidson, vice-president of Saco-Lowell Shops; Raymond P. Felkel, deputy chief, Operations Division, Boston Ordnance District; and Walter B. Mossenburg, general sales manager, Industrial Products Department, East Springfield Works, Westinghouse Electric Corporation.

The subject resulted in some lively discussions. Following the seminar, a film entitled "On Target—the Atlas ICBM" was shown, and then the early crowd joined other members at the Officers' Club for a reception and dinner where Post President John H. Gannett presided.

The guest speaker, Thomas L. Phillips, of Raytheon Company, was introduced by Dr. Ashley Farrar, assistant vice-president and director of marketing for Raytheon.

Mr. Phillips showed some recently released films of the air-to-air Sparrow III and surface-to-air Hawk missiles, developed by his company. In his talk he emphasized our missile dilemma—the need for great accuracy, reliability, and ruggedness at a price that can allow quantity production.

Brig. Gen. John W. Cave Addresses Meeting Of A. O. A. Washington Post

Brig. Gen. John W. Cave, Chief of Program Coordination, Office of the Chief of Ordnance, was guest of honor at the February Washington Post luncheon at the Willard Hotel.

General Cave explained the management responsibilities in Army Ordnance for developing and producing weapon systems. He noted that the annual expenditure of about $3 billion in this category requires decentralization of management into commodity commands. Since a weapon system will involve several commodities, for example, vehicles, fire control, and gun or missile, one command is given the responsibility for coordinating the entire system.

The numerous operations that are necessary to procure a battle-ready weapon system were featured concisely in a set of slides showing district procurement operations, climatic and service testing, packaging, and training. The general noted that these steps were always preceded by the work of the scientists, engineers, and designers who plan the system.

In two special films General Cave showed Nike Zeus test shots and a Hawk

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Environmental testing of TARmac ASR-4 Airport Surveillance Radar System, developed and produced for the Federal Aviation Agency.

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Association Affairs (Contd.)

antiaircraft missile shooting down an Honest John rocket.

Post President Stewart Magee introduced the following guests at the head table: Maj. Gen. N. M. Lynde, Assistant Chief of Army Ordnance; Rear Adm. M. E. Hubbard, Ship Characteristics Board, Office, Chief of Naval Operations; Brig. Gen. H. F. Bigelow, Deputy Chief of Army Ordnance; Brig. Gen. E. F. Cook, Deputy Chief Signal Officer; Brig. Gen. G. C. Carlson, Assistant Chief of Army Ordnance; Capt. J. A. Pridmore, U.S.N., Executive Director, Fleet Readiness Division, Bureau of Naval Weapons; Capt. H. A. Seymour, U.S.N., Executive Director, Administration, Bureau of Naval Weapons; M. C. Richmond, Post vice-president; and W. J. Reed, Post secretary-treasurer.

Track And Suspension Section Responds To Call For Help On Detroit Arsenal Problem

The Track and Suspension Section, Tactical and Combat Vehicle Division, responded to a call for technical assistance by means of an unusual meeting held at the Cadillac Motor Car Division, GMC, Cleveland Ordnance Plant, in January. The Packaging Engineering Section, Detroit Arsenal, requested A.O.A. recommendations on surveillance tests conducted on rubber bushings and replaceable rubber grouser pads in the T91E3 tracks.

Eighteen Section members, headed by Chairman Joseph Proske, Burgess-Norton Manufacturing Company, Geneva, Ill., met with fifteen Government representatives and seven members of the staff of the Cleveland Ordnance Plant.

C. L. McDermit, Detroit Arsenal, program chairman, advised that the tracks had been in storage from 5 to 7 years prior to their recent assembly and test run of about 1,000 miles. The track specimens were then viewed by the Section members.

After discussing the evidence of the tests, Mr. Proske presented the following Section answers and recommendations. Either "flat" or "curved" pack storage was satisfactory for the bushings. Track should preferably be stored indoors, but if stored outside it should be covered by tarpaulins, polyethylene covers, or other similar protection. Also, track stored outside should be inspected at least annually. Wherever stored, rusting of metal track components dictates thorough reinspection, cleaning, and reapplication of preservative compounds.

It was also noted that the importance of environment as well as age in storage and preservation is important in extending the storage life of track. Recommendation was made that the present approach

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to the problem be continued, but that test mileage should be extended to that in military qualification tests.

Citadel Post Hears Talk On Submarine Warfare By Comdr. W. A. Grossetta

The Citadel Post launched one of its most active seasons with a winter meeting attended by forty-nine cadets. Cadet 1st Lieut. A. S. Slovacek, newly elected Post president, introduced the other officers who are: Cadet 2nd Lieut. H. M. Reed, vice-president; Cadet Cpl. S. R. Bird, secretary; Cadet Cpl. A. W. Katz, treasurer; and Lieut. Col. T. N. Courvoisie, the faculty adviser.

The 1960 program was discussed and plans made to hold two other meetings at the Citadel and to visit Aberdeen Proving Ground in the spring.

On March 8th the Post met to hear Comdr. W. A. Grossetta, operations officer, Submarine Squadron 4, on the subject of ordnance in submarine warfare. He described the employment of torpedoes, mines, and underwater missiles and the latest developments in submarine designs including the Albacore-type and the Polaris-missile-launching undersea craft. He also explained the duties of an ordnance officer of a submarine.

General Rawlings Conducts Meeting Of Executive Board Of The Logistics Division

Gen. E. W. Rawlings, U.S.A.F. (Ret.), General Mills, Inc., Minneapolis, Minn., conducted a meeting of the Logistics Division Executive Board in January at the Wright-Patterson Air Force Base, Dayton, Ohio. Problems discussed included those of types of projects to be undertaken, the approach to problems received, and the most effective method of staffing the Division.

Board members present were Maj. Gen. F. J. Dau, Champion Paper and Fibre Company, Hamilton, Ohio; J. M. Ewell, Procter & Gamble Company, Cincinnati; E. L. Lape, United Motor Service Division, GMC, Detroit; S. C. Pace, Thompson Ramo Wooldridge Inc., Cleveland, Ohio; J. W. Buffington, General Mills, Inc., Minneapolis; and Maj. Gen. E. P. Mechling, A.O.A. staff director for technical operations, Washington, D. C.

To minimize duplication of effort, it was decided to coordinate closely with the Assistant Secretary of Defense to keep informed of studies being conducted by the services. Other study areas would be forwarded to the Section chairmen for

Auxiliary Gas Turbines becoming a prime power source for industry

Helmut Schelp, chief engineer, AiResearch Manufacturing Division of Arizona, Phoenix, surrounded by typical gas turbines now in production ranging in size from 30 to 850 hp. Clockwise from the top: GTC 85-28 GTCP 105 • GTP 70-6 • GTP 30-1 • GTP 70-10 • GTU 85-2.

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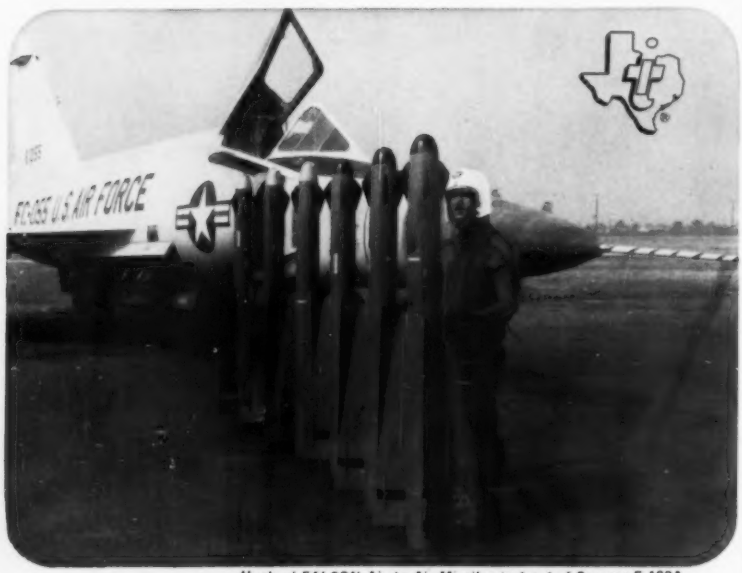

Hughes' FALCON Air-to-Air Missiles in front of Convair F-102A

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action and for guidance in staffing the Sections. General Mechling reviewed the requirements for Section members and the procedures for obtaining Government consultants.

Admiral Stroop Is Honored Texas Style By Lone Star Post At Dallas Meeting

It was Navy Day in Dallas when the Lone Star Post members turned out in large numbers on Friday, March 11th, to welcome Rear Adm. P. D. Stroop, Chief of the Bureau of Naval Weapons.

In the crowd of over 400 were a number of officials from the recently formed Panhandle Chapter in Amarillo led by John C. Drummond, manager of the Pantex Ordnance Plant. His group included M. E. Shaw, Chapter president; Maj. Bobby Scott, U.S.A.F., vice-president; W. R. Rollen, secretary; and Milton R. Hill.

The program was conducted at the Oak Cliff Country Club where Post President W. F. Joyce as presiding officer greeted the guests and presented Admiral Stroop, who was initiated into the A.O.A.'s Dallas-Fort Worth fraternity in true Texas style with a presentation of the complete regalia—Stetson hat, boots, spurs, and branding iron.

The admiral responded in a manner that indicated he was equally at home in Texas as on the deck of an aircraft carrier. Then in his address he gave a brief account of operations in his newly formed Bureau of Naval Weapons and brought the audience up to date on the status of our seapower and our ability to counter the threat of enemy submarines.

Standards And Metrology Division Sponsors Varied Program At Redstone Arsenal

Unusual exhibits, workshop sessions, and a panel forum, plus presentation of technical papers were the highlights of the January meeting of the Standards and Metrology Division at Redstone Arsenal, Ala.

The meeting, called by C. Thorpe Thompson, Sheffield Corporation, Dayton, Ohio, Division chairman, was keyed to "The Influence of Environment on Measurement." More than 160 members of the Division attended this unusual meeting which included a demonstration by the Bureau of Standards of the krypton 86 light source. The light wave of the orange-red line of this source is expected to be adopted soon as the world's standard of length.

A welcoming address was given by Maj.

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Bucket capacity, 2 cu. yd.; bucket reach, 50¾ in. (@ 7 ft. dump height); over-all width (bucket), 93½ in.; wheelbase, 88 in.; speeds, forward (4), 0-24 MPH . . . reverse (4), 0-30 MPH; shipping weight, with diesel engine, 20,780 lb. – with gasoline engine, 20,440 lb.

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DESIGNED FOR ACTION, controls provide instant, finger-tip shifting . . . a full range of work and travel speeds with reverse speeds 25% faster than forward speeds. Travel Range gives 2-wheel drive for roading . . . Work Range automatically puts power to all 4 wheels. Other action features: conveniently located machine and bucket controls . . . forward-reverse lever on the steering column . . . both bucket control levers with kick-out devices. Lift control releases at dumping height – tilt control positions bucket for digging.

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Watch for these new machines with the bold new design . . . they're ready to bring new standards to wheel loader operation. Take a look at the big new features that make this the easiest and fastest wheel loader to operate. Every feature is designed for *efficient work.* Plenty of horsepower . . . finger-tip steering . . . smooth, fast bucket action . . . outstanding operator comfort and safety.

Choose from two great new engines . . . the compact 4-cylinder Cat D330 Diesel Engine, turbocharged for maximum efficiency . . . or the 6-cylinder gasoline engine. Both are 105* HP units. Whatever your requirements, there's a No. 944 powered to meet your needs. Get the complete facts on the No. 944. See your Caterpillar Dealer the week of March 14. See for yourself how the new design pays off on your loader jobs!

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Gen. J. B. Medaris, Commander, Army Ordnance Missile Command, and Col. Henry N. Marsh, A.O.A. vice-president in charge of national Technical Divisions, briefed members on technical operation activities.

Papers presented included: "Measurement and Environment," by A. G. McNish, National Bureau of Standards, Washington, D. C.; "Controlled Environment for Measurements," by H. O. Biggs, Sandia Corporation, Albuquerque, N. Mex. A paper on "Environmental Effects on Dimensions," prepared by F. C. Victory, Moore Special Tool Company, Bridgeport, Conn., was read by M. L. Fruechtenicht, Frankford Arsenal, Philadelphia, Pa. Another paper dealing with "The Relationship of Dimensional Standards to Missile Inertial Guidance Components" was presented by Wilhelm Angele, Army Ballistic Missile Agency, Redstone Arsenal, Ala.

"Environmental Control of Electronic Calibration Laboratories" was discussed by W. F. Snyder, National Bureau of Standards, Boulder, Colo., at the afternoon meeting. Other papers were: "Optical Alignment of Large Missiles," by R. E. Godfrey, Army Ballistic Missile Agency; and "Environmental Effects on Optical Measurements," by Dr. F. E. Washer, also of the Bureau of Standards, Boulder, Colo.

The theme of the second morning session was "Summation of Environmental Criteria Affecting Measurements," with Mr. McNish acting as moderator.

The forum concluded in midmorning to allow members to inspect the extensive ABMA facilities.

Mr. Thompson announced that next year's meeting will be in Albuquerque, with the theme, "Standards and Production."

Admiral Martell Tells Washington Post About New Weapons For Naval Warfare

Naval weapons were highlighted at the March 17th luncheon meeting of the Washington Post. Rear Adm. Charles B. Martell, Assistant Chief of Naval Operations for Development, as the guest speaker gave an illuminating and refreshing summary of the impact of research on naval warfare, particularly naval ordnance.

After a brief reminder that sea power enabled the United States to project its air and land power overseas, the admiral gave a progress report on the Polaris weapons system and antisubmarine warfare in general. He outlined the technical problems that had been overcome so that now there were four Polaris submarines launched. Moreover, seven out of the last eight prototype Polaris missile tests were successful. He said, "Before the year's end the first two boats will have disappeared into the depths of the North Atlantic to provide continuously on station a deterrent force as nearly invulnerable as man can conceive."

In the field of antisubmarine warfare the admiral described the need for detection as well as destruction of undersea boats at greater ranges. Regarding this endeavor he said, "This we can do with rocket-projected weapons, the Asroc from our surface vessels and later with Subroc from our submarines, and with airborne weapons launched from all varieties of ships from destroyers to carriers—but we have no room for complacency in these efforts."

Admiral Martell closed with a remark that the Navy needs the support of the American Ordnance Association as much today as in the past and will need it even more in the future.

Post President Magee, prior to introducing Admiral Martell, presented the head table guests who were: Maj. Gen. Leighton I. Davis, Assistant Deputy Chief of Staff, Development, U.S.A.F. Headquarters; Maj. Gen. F. A. Hansen, Director of Supply Operations, Office, Deputy Chief of Logistics; Capt. J. C. Myers, Deputy Chief of Naval Research; and W. E. Haines and M. C. Richmond, Washington Post vice-presidents.

Anti-personnel Mine Detector AN/PRS-3 (XR-12) designed and built for the Corps of Engineers by Texas Instruments.

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A.O.A. Committee Explores Possibility Of Assisting In Human Engineering Field

A study of the needs of the services for assistance in the field of human engineering and the feasibility of establishing a permanent technical group in this area were explored by an A.O.A. ad hoc committee which met on March 11th at Washington, D. C. The committee members were called together by Dr. R. B. Sleight, Applied Psychology Corporation, Arlington, Va., who acted as chairman.

After initial orientation in the field of human engineering to obtain a working definition of the term, discussion continued on the increasing number of companies and service agencies which are

Ayres' Aerial Machine, designed by Dr. W. O. Ayres in 1885, was intended to get off the ground through compressed air generated by foot power. In this illustration of the machine, Brossel-Smith, noted graphic artist, has used his unique wood engraving technique to depict for this advertisement another of man's efforts to find the power necessary for sustained flight.

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Since Creation, man has looked out on space. At first, unknowing and incurious; then with the beginnings of understanding; now free and able to explore. Yet to move in space calls for wholly new concepts of energy.

This, then, is the working philosophy of Hercules in chemical propulsion: To design and manufacture highly concentrated packages of energy as propellants and rocket motors; each compatible, controllable, predictable; and each perfected for its specific mission.

HERCULES' BACKGROUND: A half-century of creative imagination in the evolution of propellants, from shotgun powder to the manufacture of every one of the millions of U. S. rockets fired during World War II, and now to space propulsion. Hercules facilities today encompass research, design, engineering, and staff organization for the production of the most advanced propellants. Illustrated brochure available on request.

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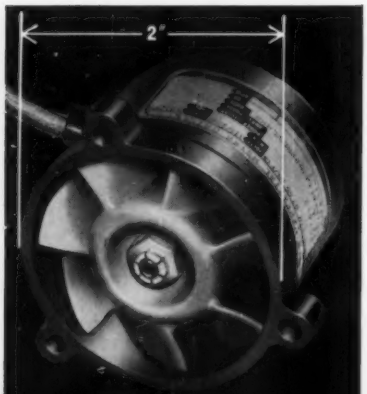

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Minifan operates up to 125°C. ambient. Its size and weight make it ideal for spot cooling, cold plates or as a cooling package component. The fan can also be repaired, greatly increasing its service life.

Range of Specifications

- **Volume flow: 21.5 to 53.5 cfm**
- **Pressure rise: .6 to 3.44 H_2O**
- **Speed: 10,500 to 22,500 rpm**
- **Single, two or three phase power**
- **Power: 16 to 69 watts**
- **Standard or high slip motors**
- **Weight: .36 to .48 lb.**

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establishing offices for the study of this science. Problems of personnel shortages and recruitment also were discussed.

Increased Government recognition of the need for human engineering, as manifested by contractural clauses, is forcing increased activity in industry. However, in many places it is still difficult to obtain proper incorporation of these factors throughout developmental and production stages.

Further discussion reviewed work by other associations to assure avoidance of duplication of effort if a unit is organized. It also was noted that any such unit would not compete with professional consultants and in all probability would increase their work by greater recognition of their potential contributions. Further action on A.O.A. operations in the field of human engineering will be considered later.

Members present included Dr. G. H. Mowbray, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.; Irving Goodman, Litton Industries of Maryland, Inc., College Park, Md.; Dr. R. M. Michaels, Bureau of Public Roads, Washington, D. C.; Dr. John Weisz, Aberdeen Proving Ground, Md.; Dr. P. G. Cheatham, Office of Naval Research, Washington, D. C.; Lieut. Col. J. H. Ritter, Air Research and Development Command, U. S. Air Force, Washington, D. C.

Maj. Gen. E. P. Mechling, staff director for technical operations; and Col. H. C. Thayer, staff director for public information, represented A.O.A. Headquarters, Washington, D. C. Dr. H. P. Van Cott, International Business Machines Corporation, Bethesda, Md., was unable to attend this meeting of the committee.

A. O. A. Fire Control Section Meets At Naval Electronics Laboratory, Calif.

An opportunity to get first-hand information on some of the Navy's programs and to see some of these projects in operation was given to members of the Fire Control Section, Underwater Ordnance Division, during a meeting at San Diego, Calif., in January.

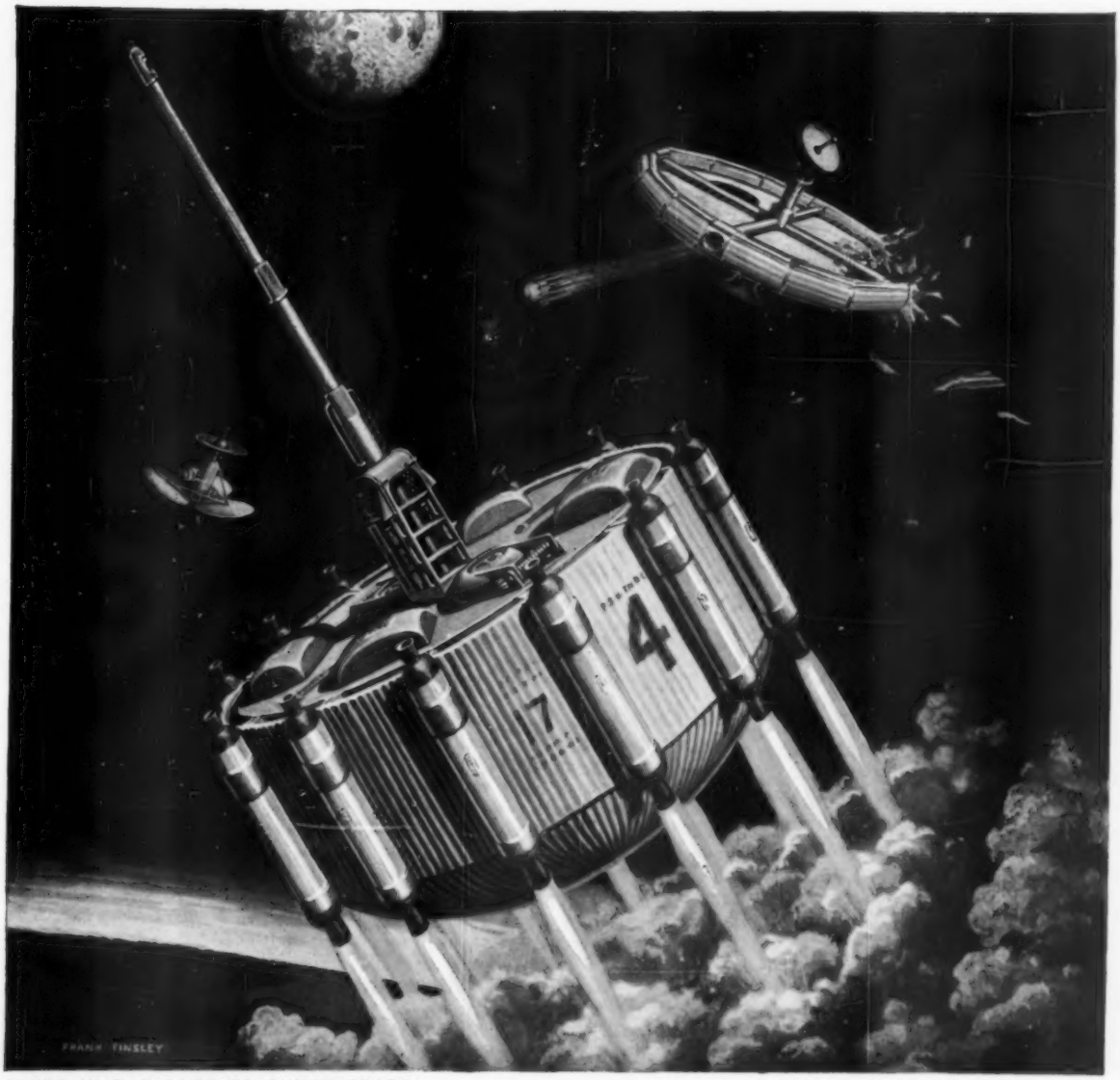
Dr. A. D. Anderson, Cook Electric Company, Morton Grove, Ill., chairman, introduced Capt. J. M. Phelps, commanding officer, Naval Electronics Laboratory, San Diego. Captain Phelps described the laboratory mission of conducting research and development programs in the fields of electronics and related sciences. This includes instrumentation for analysis of environmental effects and human factors. In addition, NEL provides consultant services and sea-test facilities for Navy contractors.

A description of the organization and allocation of the responsibilities of the Bureau of Naval Weapons was given by Comdr. J. A. Grace and E. A. Pittman, BuWeps, Washington, D. C.

The lecture program and tour of NEL and the Naval Tactical Data System were directed by Comdr. L. A. Franz, NEL. Members observed NEL training facilities and sonar school activities. Various techniques and training devices for processing new information to fleet personnel as new developments become operational also were described.

The NEL scientific staff presented a series of classified papers on the following subjects: "Pro-Submarine Countermeasures," by K. E. Geren; "Signal Processing and Signal Enhancement," Dr. J. L. Stewart; "Long-Range Sonar Range and Bearing Accuracy Tests," by K. V. MacKenzie; "Active Homing Sonar Techniques," by R. L. Waldie; "Submarine Target Classification," by Comdr. A. C. Carson; "Employment of Digitalized Sonar Data in NTDS," by R. H. Harwood; and "Sonar, Present and Future," by Dr. D. A. Wilson. There also was a presentation and film on NTDS by Lieut. Comdr. A. M. Bettis.

At head table at Fire Control Section Meeting, l. to r.: John Litsios, Maxson Corp.; Thomas Bryant, Librascope; Paul Cohen, Sperry Gyroscope; Richard Miner, Thompson Ramo Wooldridge Inc.; Dr. Alton Anderson, chairman; Comdr. J. A. Grace, BuWeps; Al Clemenson, Arma Corp.; George Robertson, General Electric (Navy photo).



STEPS IN THE RACE TO OUTER SPACE

Escape In Space

The space-assembled super satellites of the future will periodically encounter disaster—collision, mechanical failure, military attack, or the long chance of being hit by a meteorite. When this happens, "life boats" like the one shown here will bring their crews safely back to earth.

Here is the operational sequence of an escape in space:

1. Crew members don pressure suits and strap themselves into decelleration beds within the pressure-intact unit.

2. At the "Abandon Ship" signal, low-power, RATO-type launching rockets blast the sealed capsule from the threatened station (upper right illustration).

3. Acting on orders from an astrogational computer, the retro-rockets check the capsule's speed and break it out of orbit. (Foreground. Note details of offset heat shielding, hatches, slow-down parachute covers.)

4. As the capsule enters the outer atmosphere, the heat shield protects the astronauts. The life boat's momentum slows even further, and the shield is jettisoned as it cools.

5. Four parachutes are released, acting as air brakes. After a computed interval, other chutes are released.

6. The capsule lands in a predetermined sea rescue area, and a ring of flotation bags inflate. A radio broadcasts the craft's location, and a bright sunshade serves as a visual and radar target for rescuers.

ARMA, now providing the inertial guidance system for the ATLAS ICBM and engaged in advanced research and development, is in the vanguard of the race to outer space. For this effort, ***ARMA*** needs scientists and engineers experienced in astronautics. ***ARMA***, Garden City, New York. A Division of American Bosch Arma Corporation.

AMERICAN BOSCH ARMA CORPORATION

United Research Corporation of Menlo Park, a subsidiary of United Aircraft Corporation, announces it has changed its name to

UNITED TECHNOLOGY CORPORATION

Objectives of this company have evolved to encompass not only research but also development work in the fields of solid and liquid propellants through complete qualification of rockets and of advanced propulsion systems.

The new name — with its emphasis on "technology" — clearly defines the scope of the activities being undertaken.

Construction of two multi-million dollar permanent facilities to implement the objectives of the corporation is now underway. A Research and Engineering Center is being built on a 25-acre site in Sunnyvale; a Development and Test Center in the foothills some 10 miles southeast of San Jose, California, in the prime living area of the San Francisco Peninsula.

UNITED TECHNOLOGY CORPORATION

P. O. Box 365 • Menlo Park, Calif.

Capital Cities Post Marks Tenth Year, Honors Robert Sprague At Meeting

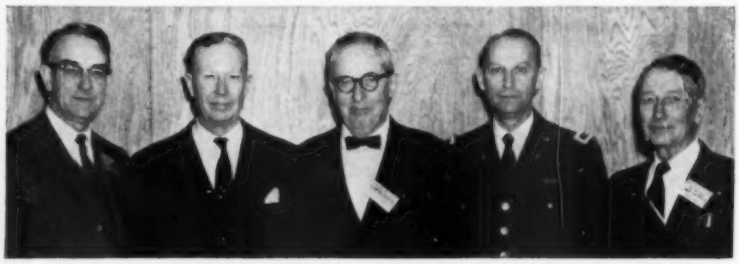
The Capital Cities Post met in Albany, N. Y., on March 1st to commemorate its tenth anniversary and honor Robert C. Sprague, Sr., chairman of the board, Sprague Electric Company. A representative crowd from all regions of the Post braved a winter storm to assemble at Herbert's Restaurant.

The presiding officer, Col. Walter M. Tisdale, first vice-president, reminded the members that their Post was inaugurated in February 1950 with 250 members and now boasted a membership of 555 and had a long-standing record of holding at least three meeting each year. In addition the members have always taken a friendly interest in engineering students in all the local colleges and prospective engineers in the high schools, awarding prizes and giving talks.

To continue this program, Col. O. R. Schurig proposed the establishment of a panel of speakers for 1960 to talk to high-school students about the engineering profession and its many fields of opportunity.

Rear Adm. W. D. Leggett, a director and National Council representative of the Post, introduced Mr. Sprague who spoke from his experiences as chairman of the Federal Reserve Bank of Boston.

The excellent arrangements for this meeting were under the able direction of Chace Sherman, program chairman, assisted by John E. Benson.



Present at Capital Cities Post meeting were, left to right: Rear Adm. W. D. Leggett, A.O.A. Council representative; Robert C. Sprague, Sr., chairman, Sprague Electric Company; H. L. Erlicher, former assistant to the Secretary of the Army; Col. Walter M. Tisdale, Post vice-president; and Capt. J. S. Evans, U.S.N. (Ret.). This meeting marked the tenth anniversary of the founding of the Post.

• **BRIG. GEN. WILLIAM IRVING WESTERVELT**, distinguished Army Ordnance weapons expert, died at Brattleboro, Vt., March 2, 1960. He had been residing there since his retirement from the engineering profession some years ago.

The name of General Westervelt always will be associated with one of the major weapons programs of the Army following the First World War. He was the president of a board of seven officers appointed immediately upon termination of that war to set the specifications for the development of modern field artillery.

A native of Texas, General Westervelt was graduated from the United States Military Academy in 1900. Later he served as instructor in physics at the Academy. During the closing months of World War I he was Assistant Chief of Artillery of the American Expeditionary Forces in Europe. Prior to his retirement from active duty in 1923 he served as commanding officer of the Watervliet Arsenal. For four years, 1923-1927, he was Technical Military Attaché for Western Europe with headquarters at the United States Embassy in Paris.

Upon his retirement from active duty he became technical director of Sears, Roebuck & Company, and later organized the company's research laboratories and directed their operations. He retired from Sears in 1938 and became affiliated with Ross & Company, engineers and consultants in New York. He took up his residence in Burlington, Vt., in 1951.

A charter life member of the American Ordnance Association, General Westervelt was prominent also as a member of the American Society of Mechanical Engineers and a director of the Encyclopædia Britannica. He held a number of United States and allied military decorations awarded during the two World Wars as well as citations for service during the Mexican Border campaign.

• **REAR ADM. WALTER V. R. VIEWEG** died in Bethesda Naval Hospital, Chevy Chase, Md., on March 20, 1960. He

(*Continued on p. 912*)

USAF F-105

FUEL PUMPS DESIGNED, MANUFACTURED, SERVICED BY THE TAPCO GROUP

The Republic F-105 Thunderchief, in operation with Tactical Air Command, is an all-weather fighter-bomber of tremendous power. It can climb to 8,200 feet in 55 seconds from standstill on the runway.

For congruity with such performance, the airplane's fuel booster pumps were specially designed to prevent vaporization. There are four of these pumps, and a main-and-after-burner pump in the F-105, each designed, manufactured and serviced by the TAPCO Group. Other TAPCO products in the Thunderchief: compressor rotor blades, stator vanes and turbine blades for the Pratt & Whitney Aircraft J75 engine.

Design ingenuity is a prime capability of the TAPCO Group. That is one reason we have been a part of every major aircraft program since the B-17 in 1939. Including, today, the A3J, F8U, W2F1, T-38, 707, ELECTRA, 880, KC-135, B-52, and B-58.

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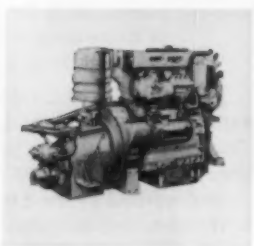
Pre-1931 diesel engines were big and heavy. Although they were efficient, economical and uncomplicated, they only could be used where there was room for their bulk and for the massive foundations they required. Diesels, at that time, couldn't be used for mobile applications like those Caterpillar required. So Caterpillar designed and built its own diesels.

Compact, lighter and more versatile—the first Cat Diesel Engine revolutionized mobile power.

Today, with over thirty years of diesel experience, Caterpillar has built hundreds of thousands of these compression-ignition



engine power

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engines. Modern Cat Diesels are light, compact and efficient. They are probably the most advanced diesel engines made. They are available for practically every diesel or natural gas application.

Modern, lightweight, compact Cat Diesel Engines are available in horsepowers to 730 or Electric Set ratings to 375 KW. For use in construction, mining, railroad, petroleum, agricultural, marine, pleasure craft, logging, and public service applications.

CATERPILLAR

Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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Official United States Navy Photograph

Sparrow III Navy air-to-air missile is now operational with both the Sixth and Seventh Fleets. Raytheon is prime contractor for this potent weapon.

RAYTHEON COMPANY, WALTHAM, MASS.

RAYTHEON

EXCELLENCE IN ELECTRONICS

"NITRASOL" GOES INTO PRODUCTION

Performance and Safety Proven

Scientists at Grand Central Rocket Co. have enormously widened the margin of advantage of the solid propellant over liquid, in *practical* application,

with development of a new high-energy nitrocellulose-aluminum perchlorate solid propellant named Nitrasol—now in pilot production at GCR.

In March a completely case-bonded, cast-in-place missile motor of Nitrasol was temperature-cycled repeatedly from minus 75°F to plus 165°F and then successfully fired at minus 68°F. Such motors have excellent storage characteristics. They can be stored for extensive periods, then fired at an instant's notice.

These qualifications adequately fulfill the conditions of environmental storing, handling and tactical deployment which the military services would ideally hope to specify but which until now have not been realized in any high-energy propellant.

High production rates in a low cost facility make Nitrasol even more attractive. The four ingredients are easily and safely combined; organic nitrate plasticizer-stabilizer solution, fine-particle nitrocellulose, ammonium perchlorate and aluminum particles.

The feasibility of mixing Nitrasol in GCR's Redlands plant and transporting it to any location in the U.S. for subsequent casting in large-volume solid motors is yet another possibility of Nitrasol—perhaps the most promising propellant in existence today.

Positions open for chemists, engineers and solid rocket production specialists.

Grand Central Rocket Co.

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REDLANDS, CALIFORNIA

had been a member of the Association for over six years and had served in its Underwater Ordnance Division.

Admiral Vieweg, as commanding officer of the escort carrier GAMBIER BAY, was awarded the Navy Cross for his heroic actions in the Second Battle of Leyte Gulf, in engaging superior Japanese forces, and in rescue operations after his ship was sunk in the battle. Earlier in the war he was head of the Aviation Ordnance Section, Navy Bureau of Ordnance.

Following the GAMBIER BAY episode, Admiral Vieweg commanded the COMMENCEMENT BAY, another escort carrier, and served as commander of the Naval Ordnance Test Station, China Lake, Calif.; commander, Naval Aviation Ordnance Test Station, Chincoteague, Va.; and commanding officer of the carrier KEARSARGE. His last active duty was as commander, Fleet Air, Hawaii.

He was designated a naval aviator in 1926 after graduation from the U. S. Naval Academy in 1924. From 1929 to 1933 he was assigned to the aviation-ordnance postgraduate course at Annapolis. Since his retirement in 1954, Admiral Vieweg had been with General Dynamics Corporation as coordinator of antisubmarine-warfare programs.

Besides the Navy Cross he was awarded two commendation ribbons and a Presidential Unit Citation.

• **COL. WILLIAM J. CROWE**, retired Army Ordnance Corps officer and former commandant of the Springfield Armory, died at Westover Air Force Base Hospital, Mass., on February 23, 1960.

He entered West Point in 1917 and after graduation served in the Cavalry under then Maj. George S. Patton, Jr. For the last five years Colonel Crowe had been with the research and development department of the Savage Arms Corporation in Chicopee Falls, Mass.

Colonel Crowe had been a member of the Association for over twenty-six years and was always deeply interested in the affairs of the Association. He was secretary-treasurer of the Hartford-Springfield Post for the past two years and for many years prior to that was a director of the Post. Since his retirement he had been secretary of the Machine Gun Section of the Small Arms and Small Arms Ammunition Division.

In World War II he commanded supply depots in England and France. Colonel Crowe, who held a bachelor's degree in mechanical engineering from Massachusetts Institute of Technology, was a graduate of the National War College in Washington and the Command and General Staff School at Fort Leavenworth.

Colonel Crowe is deeply mourned and sorely missed by his many friends throughout the Ordnance fraternity both in the Association and the Ordnance Corps.

• **COL. JAMES C. HECKMAN**, a charter life member of the American Ordnance Association, died in New York City, December 2, 1959. He was a consulting engineer of distinction and served in the Ordnance Department of the Army in World War II. He was an active Reserve Officer who for many years was prominent in the activities of the Association's New York Post.

A native of New Jersey, Colonel Heckman was graduated from Lafayette College and did postgraduate work at Massachusetts Institute of Technology. He entered the Officers' Training Camp at Plattsburg Barracks, N. Y., in July 1916 and later was commissioned a major in the Ordnance Section of the Officers' Reserve Corps. In July 1918 he was promoted to the grade of colonel. During World War II he served in France and England. He was awarded the Distinguished Service Medal and was cited for "exceptionally meritorious and distinguished services in the performance of duties of great responsibility."

He assisted in formulating the general program of ordnance storage depots and planned and operated with marked success those establishments assigned to the Ordnance Department.

Colonel Heckman was associated with the engineering firm of Stevenson, Jordan and Harrison from 1938 until his death. A past commander of the Larchmont (N. Y.) Post of the American Legion and prominent as a member of the American Society of Mechanical Engineers, his civic interests were many. He served long as president of the board of trustees of the Larchmont Public Library.

• **COL. LUCIAN D. BOOTH**, charter member of the American Ordnance Association, died at Roanoke, Va., February 11, 1960. He served with distinction in the Ordnance Department of the Army for many years.

Colonel Booth was graduated from the United States Military Academy in 1907. Commissioned in the Coast Artillery Corps, he was subsequently an instructor in ordnance and gunnery at West Point. During the First World War he served in France as Ordnance Officer of the 30th Division, A.E.F. He later became Ordnance Officer of the First Army.

Prior to World War II, Colonel Booth was chief of the Ammunition Division, Office of the Chief of Ordnance, and later was commanding officer of the Ordnance Plant at Radford, Va., which was operated by the Hercules Powder Company. He retired from active military service in 1944 and became interested in civic affairs in Roanoke, where he was a member of the Roanoke School Board. He was also an avid student of military history and was prominent in Roanoke's historical projects.

(*Continued on p. 914*)

He took the luck out of heads or tails

This AMF engineer had a delicate problem: to accomplish the separation of the expended stages of a multi-stage rocket. If separation occurs too soon, thrust in the nearly burned out stage may exceed the aerodynamic drag, the tail overtakes the head, and...boom. A million dollar collision and no insurance.

His solution: An acceleration switch that turns the burned out stage loose at the right split second ...a switch that makes rockets think for themselves.

His switch is compact. It is designed to work in any missile at any range with any payload. It is ingeniously simple in conception, design, and operation. A spring is attached to a free swinging hammer, the spring force acting to pull the hammer against the contact plate. At calibration the spring can be set to oppose any G from 1 to 100. When the missile is launched, the hammer is held back by the acceleration forces until the stage decays to the desired separation G. When the spring force overcomes the forces of acceleration, the hammer comes forward, strikes the contact plate, and the circuit required to make separation is closed automatically. No guesswork, no luck, no *collision.*

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This simple solution to a tricky problem reflects the resourcefulness of AMF people.

AMF people are organized in a *single operational unit* offering a wide range of engineering and production capabilities. Its purpose: To accept assignments at any stage from concept through development, production, and service training... and to complete them faster...in

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In engineering and manufacturing AMF has ingenuity you can use...

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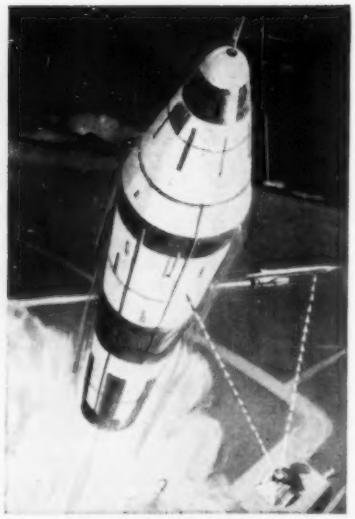

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Avco/Crosley is looking for qualified individuals to share in the development of new and exciting concepts in communications. At Crosley, a wide range of communications projects offers challenging opportunities to experienced personnel.

Research and Development activity extends from Range Safety Receivers for missiles to Meteor-Trail Scatter Systems for reliable long-distance radio links, and includes advanced concepts in tactical communications for mobile units.

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Accelerated research into the development of Radar Systems has also created unusual positions in this fast growing field. Specific areas of interest include:

- Microwave Techniques
- Circuit Design and Development
- Solid State Building Blocks
- Pulse and Video Circuitry

For more information, write to Mr. P. B. Olney, Manager of Scientific and Administrative Personnel, Dept. O-50, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco / Crosley

Necrology

• **KENNETH A. SPENCER**, founder and chairman of the Spencer Chemical Company, Kansas City, Mo., and a life member of the American Ordnance Association, died in Miami Beach on February 20, 1960.

A graduate of the University of Kansas, Mr. Spencer began his career with the Pittsburgh and Midway Coal Mining Company of Kansas City and became its president in 1943. In 1941, at the request of the War Department, Mr. Spencer established a company—Military Chemical Works, Inc.—to build a plant for the production of chemicals for wartime explosives. The plant, known as the Jayhawk Ordnance Works, Baxter Springs, Kans., went into operation in 1943.

At the end of World War II, Mr. Spencer converted Jayhawk to the production of nitrate fertilizer for export by the Commodity Credit Corporation. He acquired the plant, and Military Chemical Works, Inc., became the Spencer Chemical Company.

He was a director of many companies throughout the Midwest, a trustee of the Research Foundation of the University of Kansas, and a member of the board of governors of the Midwest Research Institute.

Mr. Spencer also was a member of the business advisory council of the Department of Commerce. In 1943 he received a University of Kansas citation for outstanding achievement and in 1957 received the memorial award of the Chemical Market Research Association.

• **CHARLES ARTHUR JOHNSTON**, veteran civilian engineer with the Navy and prominent in development of its missile programs, died at the National Institutes of Health, Washington, D. C., on February 29, 1960.

Mr. Johnston was a tower of strength in the affairs of the Technical Divisions and Sections of the Association in his capacity as a member of the liaison committee in the Bureau of Naval Weapons. His wide knowledge of ordnance and friendly advice were sought often by those who worked directly in the Technical Divisions.

After many years of duty in West Coast shipyards, he came to Washington as head of the Rocket and Design Section in the Bureau of Ordnance. In 1952, as chief engineer of the Naval Avionics Facility in Indianapolis, he was instrumental in perfecting the design of aircraft control systems. Since 1955 he had been chief engineer of the Research and Development Divisions of the Bureau of Ordnance and later of its successor, the Bureau of Naval Weapons.

He received the Navy's Distinguished Civilian Service award for his outstanding work in the field of missiles.

NEW, HIGH CAPACITY COMPRESSOR

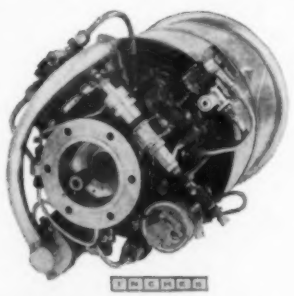
BY STRATOS

The **PCM3-4**—a compact 3000 psi compressor delivering 12 scfm.

Ideal for ground support and airborne applications, this **compact** new compressor delivers **12 scfm** of air at 3000 psi. A four stage compressor designed in a 90°V shape, the unit weighs less than 39 pounds; its envelope measures only 13.5 inches in diameter and 18½ inches in length. Self cooling by an integral fan plus an efficient inter-cooling system are provided. An unloader valve and a pressure regulator are incorporated for automatically controlling output and inlet pressure. The compressor can be operated with an unpressurized inlet. The PCM3-4 is adaptable to turbine, hydraulic or electric drive.

SPECIFICATIONS

COMPRESSOR		
Discharge Pressure	Maximum Rated	3000 psig
Delivery Capacity	Rated	12 scfm
Compression Stages		4
Speed	Rated	4000 rpm
Driving Horsepower		13.5
Inlet Pressure		14.7 psia
Inlet Temperature		59°F
CONTROLS		
Cut-in—Cut-out Differential		300 psi
Cut-in Pressure		2800 psi
Cut-out Pressure		3100 psi
Pressure Relief		3300 psi
ENVIRONMENTAL		
Low Temperature		−65°F
High Temperature		+165°F



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Redeye, the first man-transportable guided missile, offers unprecedented new protection for ground troops against air attack. A one man operated defense system, Redeye can be hand-carried into areas which heretofore were inaccessible to any anti-aircraft weapon. It is now being developed at the Pomona facility of the Convair Division of General Dynamics for the U.S. Army and Marine Corps.

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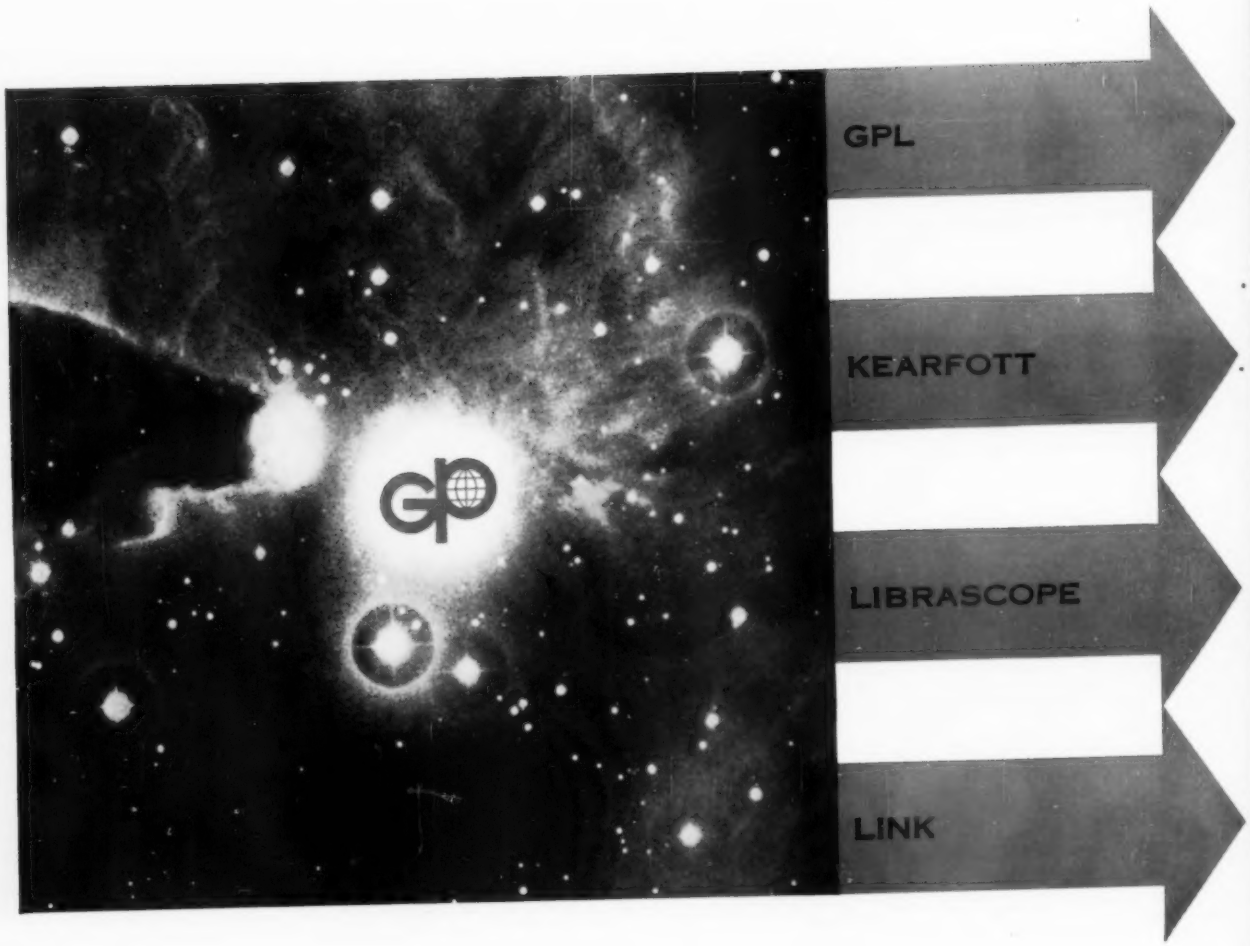

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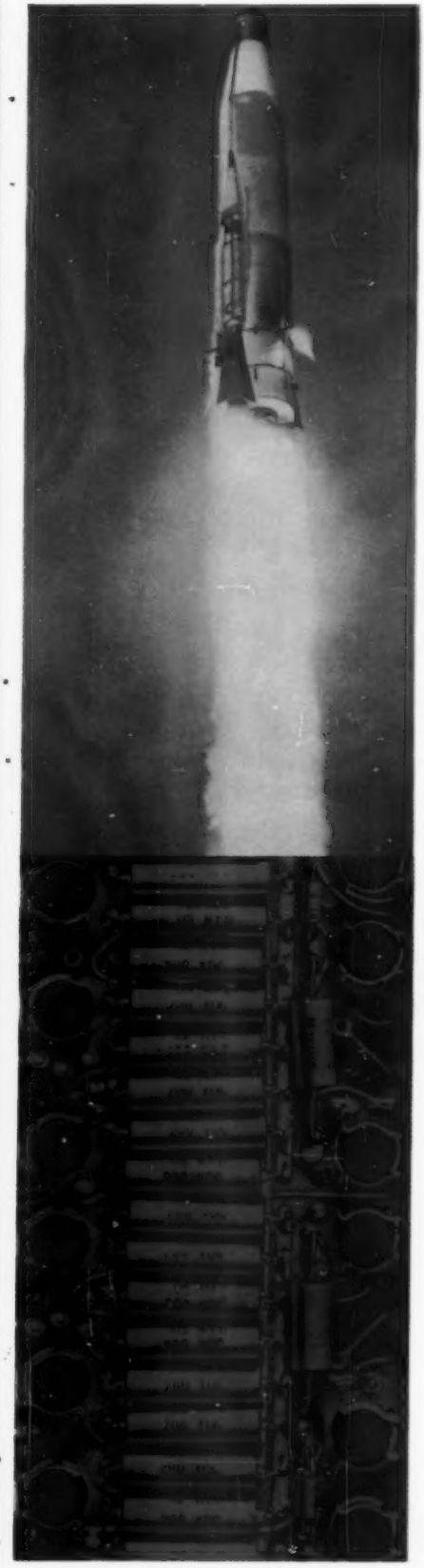
ORDNANCE



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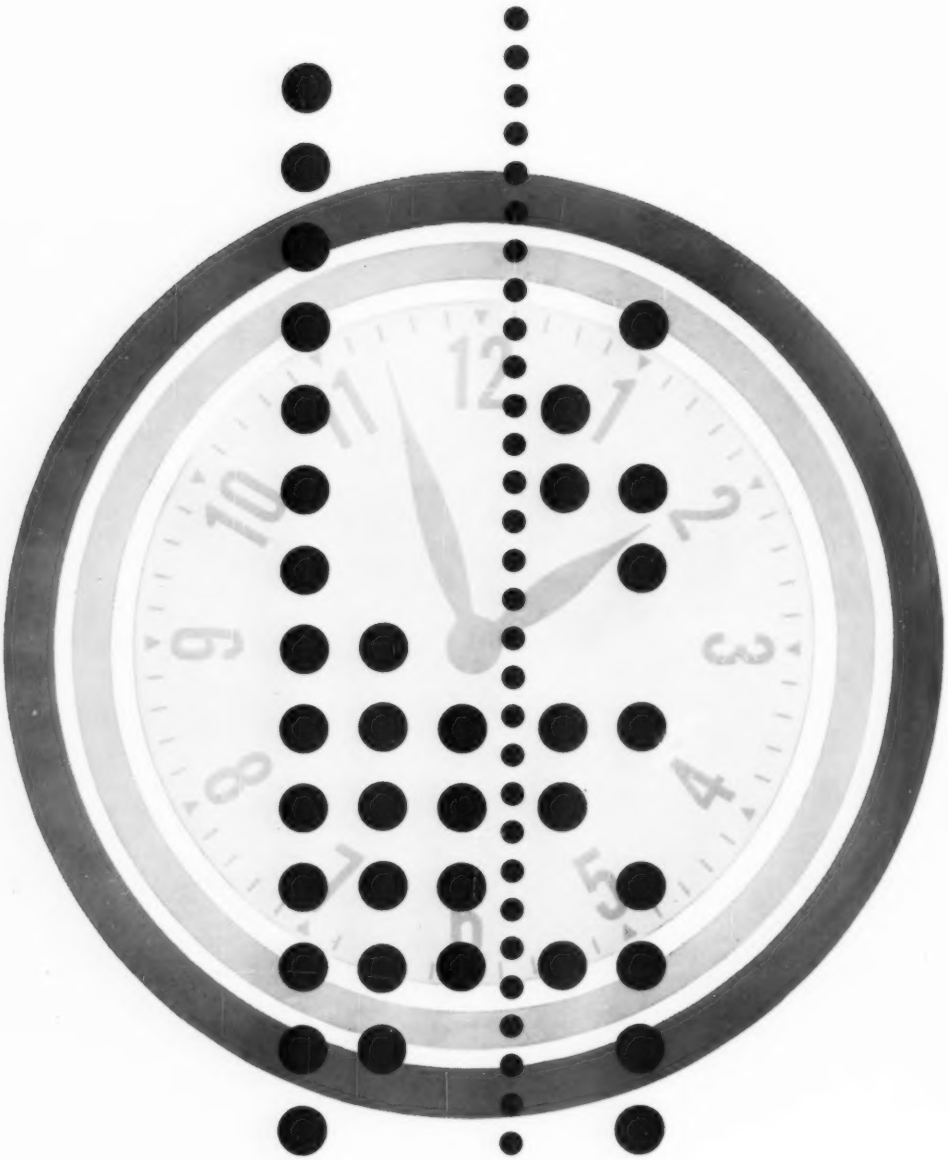

TAPE AND MICROSECONDS

are essential to missile development. Instruments must record every function against time... in fractions often finer than one ten-thousandth of a second. Reams of electronic and optical data must be collected, reduced and evaluated before any missile can become operational. Vitro designed, built and helped instrument the Air Force missile test center at Eglin Air Force Base, Florida. Today it operates the center's test ranges and tracking stations throughout the Southeast. At Eglin, Vitro and the Air Force, working as a team since 1952, are responsible for checkout of missiles, rockets, weapon systems, countermeasures, space probe vehicles and bombing techniques. Beyond this Florida site, other Vitro capabilities: underwater (torpedo) and electronic environmental ranges.

SCIENTISTS AND ENGINEERS: JOIN THIS TEAM.

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NEW DEVELOPMENTS

First Pershing Launched

The Army fired its newest and longest-range surface-to-surface missile, the Pershing, for the first time recently at the Atlantic Missile Range, Cape Canaveral, Fla. Pershing, now in the research and development phase, is a 2-stage, solid-propellant ballistic missile.

The Pershing, lighter and smaller than the Redstone system which it will replace, will be used for general support by the field army. Reliability, short reaction time, simplification of equipment, and versatility in all types of terrain and climate are goals of the system. Using inertial guidance, the Pershing will be able to direct itself to a target without possibility of outside jamming.

A new type transporter-erector-launcher (TEL) will permit the missile to be transported to a site, erected, and fired in a matter of minutes, thus giving it extremely high mobility, operating on a "shoot-and-scoot" principle. The system is both ground- and air-transportable.

Typhon Weapons System

The Navy is now developing the Typhon weapons system designed to provide the fleet with a greatly improved antiair warfare capability and an offensive capability for engaging enemy fleet units and for conducting long-range shore bombardment. The Applied Physics Laboratory of the Johns Hopkins University is prime contractor for engineering and development of the weapons system. Westinghouse Electric Corporation is prime development contractor for the weapon control subsystem.

The name "Typhon" has superseded the designation "Advanced Weapons System" formerly used to refer to improvements in the Talos and Tartar missile systems. Super Talos has been renamed Long-Range Typhon and Super Tartar is now called Medium-Range Typhon.

The system's new radar concept incorporates high data rate and high power features far in excess of present designs. This radar, together with the other elements of the shipboard weapon system, is the major contributing factor in its greatly improved performance. The weapon-control subsystem will consist of new, advanced long-range search, track, and guidance radar; high-speed computers to provide nearly instantaneous target selection and designation; and display and monitoring equipment.

New High-Speed Camera

A movie camera that can stretch the events of one second into twenty-eight hours is now in production. By combining optical, electronic, and mechanical principles, the new ultraspeed device can take from 480 to 1,600,000 pictures a second on standard 35-mm. film, in black and white or color.

High-speed equipment consists of camera, control devices, and electronic flash.

The new camera, developed by Dr. Albert T. Ellis, associate professor of applied mechanics at the California Institute of Technology, permits scientists and engineers to freeze motion while studying arc discharges, explosive reactions, fragmentation processes, high-frequency fatigue, and many other ultrafast events.

Since no mechanical shutter can approach this speed, an electro-optical shutter is used which controls passage of light by means of ultrarapid electric pulses. The shutter assembly consists essentially of two polaroid filters and a cell filled with a special substance in an electric field. When the field is off, no light passes through the assembly. When a high-energy electric pulse is applied, the light is polarized in such a manner that it passes freely through the filters. One or two optical lenses focus the image onto a rotating mirror in the film box. The film remains stationary while the nickel-plated aluminum mirror revolves at the rate of 100,000 rpm.

Infrared Search Equipment

Electronic "eyes" that cast a cold glance around the heavens to disclose the presence of enemy aircraft have been developed for the Air Research and Development Command by International Telephone and Telegraph Corporation. Engineers at ARDC's Wright Air Development Division worked with ITT in developing the equipment.

The heat-seeking equipment, with a sensing element cooled to less than 300 degrees below zero Fahrenheit, is ultrasensitive to thermal emissions from jet aircraft.

This infrared search track set, designated U.S.A.F. type AN/AAR-21, hunts and detects an enemy bomber by completely passive means; that is, no signals are transmitted from the interceptor to betray its presence to an enemy bomber. The device is optimized to detect wave lengths of heat generated by jet aircraft and is relatively invulnerable to electronic countermeasures or jamming.

Upon warning from the ground-based radar net of enemy bomber penetration of the defended zone, a high-performance interceptor is vectored to the vicinity of the bomber target. An area directly ahead of the aircraft is scanned by a search unit mounted in a forward installation on the interceptor. Upon detection of the target a second scanner is "locked" on the target to furnish track information to the interceptor weapon-delivery system.

First Minuteman Site

Malmstrom Air Force Base, Great Falls, Mont., has been selected as the support base for the initial operational deployment of the Strategic Air Command's Minuteman ICBM.

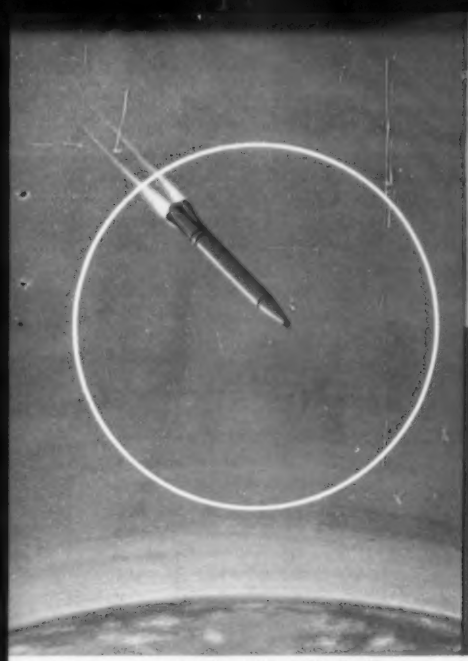
The Minuteman is the first U. S. 3-stage, solid-propellant, intercontinental ballistic missile capable of carrying a nuclear warhead. It is designed as a fast-reaction Air Force weapon system that will economically strengthen the Strategic Air Command's deterrent force of manned aircraft and missiles in large numbers.

Each of the three squadrons programmed for Malmstrom Air Force Base will have missiles located in underground silos at various locations from the support base. They also can be launched from mobile railroad cars in trains moving about the country, giving the force high survivability and the capability to retaliate successfully against an enemy even after a surprise attack.

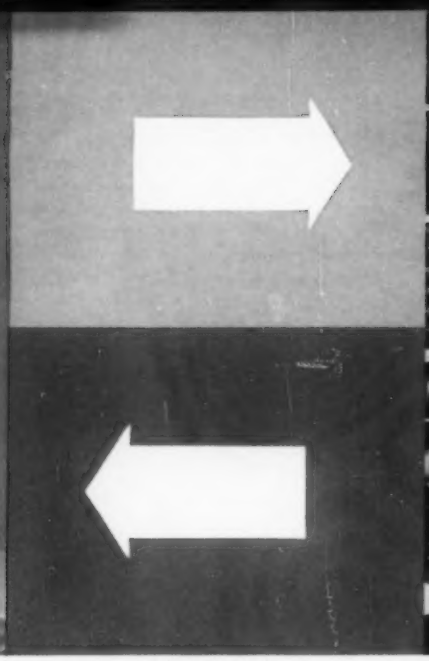
115-mm. Artillery Weapon

The Marine Corps' automatic field-artillery weapon, the 115-mm. boosted-rocket XM70, can deliver fire at the rate of 6 rounds in 2½ seconds.

Now in the advanced research and development stage, the lightweight, helicopter-transportable XM70 is this country's first automatic field-artillery weapon. It is considered by the Marine Corps to represent the most significant improvement in



Data Acquisition and Application



Data Communication

Data Processing and Control

The 3 elements of an automated military system: all logical capabilities of IBM

IBM's Federal Systems Division has a unique three-way capability. Because of it, the Division can effectively handle study and development contracts of total defense systems—or assume total system management responsibility. It can originate the systems concept and carry it all the way to implementation.

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In data processing and control subsystems—Engineers and scientists at the Federal Systems Division can draw on a vast IBM background in data processing to develop new and advanced systems and programming concepts. They can draw on existing equipment, or utilize widespread manufacturing facilities to meet both the engineering and production requirements of totally new instrumentation.

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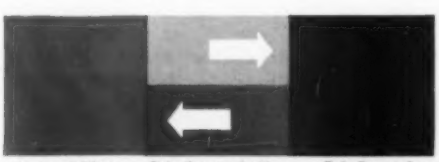

Data Acquisition and Application | Data Communication | Data Processing and Control

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conventional U. S. artillery since 1940 and is scheduled for initial operational use in the Corps early in 1962.

Automatic firing of the XM70 is accomplished with two clusters of three breech tubes each, mounted side by side. Each cluster revolves, like the cylinder of a pistol moving around into position for firing through a single-mounted launch tube (see photo on page 869).

The XM70 weighs only 3,000 pounds, is effective at greater ranges than the 105-mm. howitzer, and is capable of firing direct as well as indirect close-support missions. The weapon is easily manhandled and can be towed with a lightweight vehicle such as the ¼-ton "convertible mule."

The 115-mm. boosted-rocket round can be equipped with a point-detonating or proximity fuze, and its high-explosive warhead is effective against personnel, mechanized forces, and similar artillery targets. The main advantage of the boosted-rocket principle is that it permits lighter construction of the piece. The weapon was first publicly displayed and fired at the 41st Annual Meeting of the American Ordnance Association at Aberdeen Proving Ground last October.

Mauler Missile System

The Army has awarded a contract for $5,500,000 to the Convair Division of General Dynamics Corporation, Pomona, Calif., for development of a new, highly mobile battlefield air-defense missile system known as Mauler. This will be a compact weapon which will use solid-fueled radar-guided missiles primarily to destroy short-range, enemy ballistic missiles and rockets and high-performance tactical aircraft which bomb, strafe, harass or reconnoiter near forward battle area positions.

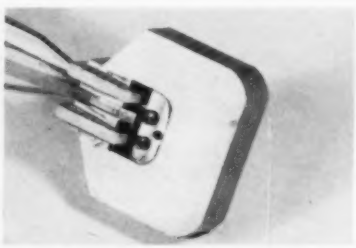
Each Mauler unit will be contained entirely in a single tracked vehicle of a standard design. It will be fully mobile and capable of delivering accurate fire even while moving. This characteristic conforms to present Army policy of giving a high degree of mobility to all its new weapons systems so that an enemy is not presented with targets which are fixed or anchored to the ground.

The Army Rocket and Guided Missile Agency, a part of the Army Ordnance Missile Command at Redstone Arsenal, Huntsville, Ala., has over-all charge of Mauler development.

Mauler missiles will be prepacked in lightweight cases that will serve both as shipping containers and as launching tubes. One man will be able to operate the system, but each Mauler unit normally will carry a crew of two or three men—the operator, driver-radioman, and, when necessary, a commander.

Electronic Ear

Development of a new electronic ear, considered one of the most sensitive listening devices invented to date and keen enough to pick up faint radio signals from interplanetary rockets, was disclosed recently by the Army. The superdetector,



Magnet at right "tunes" ruby in its jaws to operate at the correct frequency.

a 25-pound "ruby maser," developed for the Signal Corps by Hughes Aircraft Company, is the smallest and easiest-to-operate device of its kind. It could extend by tenfold the sensitivity and range of many Army electronic systems.

The "ruby maser" gets its name from the ruby gem which is its heart and from the scientific phrase describing its use—"microwave amplification by stimulated emission of radiation." In operation, a special 2-carat synthetic ruby inside the maser is cooled to 452 degrees below zero Fahrenheit—about as cold as any object in the universe can become. At this temperature the jewel can detect and amplify almost imperceptibly faint radio signals.

The ultracold temperature, maintained by immersing the ruby in liquid helium, causes atoms and electrons in the gem to move in slow motion. This cuts the "noisy" collisions of the atomic particles to a minimum. The result is an almost static-free signal booster.

Advanced Terrier

The Navy recently awarded a contract for $25.2 million to the Convair Division of General Dynamics Corporation for additional production of advanced Terrier guided missiles. The supersonic weapon will be produced at the Naval Industrial Reserve Ordnance Plant, Pomona, Calif.

The newest version in the Terrier series has greatly improved effectiveness against low-flying aircraft and multiple targets. It will extend the present antiaircraft capability to provide defense against surface targets and land installations. Advanced Terrier will have considerably more transistorization than did the original missile.

The Navy's first guided-missile frigate, the U.S.S. DEWEY, which was commissioned at the Boston Navy Yard on December 7, 1959, will be the first ship armed with the advanced Terrier. Two conventional carriers, three guided-missile cruisers, and nineteen additional guided-missile frigates also will be equipped with this missile. Eventually the weapon will be installed in the nuclear-powered guided-missile cruiser U.S.S. LONG BEACH and the nuclear-powered guided-missile frigate, U.S.S. BAINBRIDGE. The advanced Terrier will directly replace the original version of the missile in existing shipboard magazines and depots.

More Accurate Faraday

A new electrochemical determination of the faraday has been accomplished at the National Bureau of Standards. This physical constant, named in honor of Michael Faraday, is the quantity of electricity associated with a change of one equivalent weight of the reacting substance in any electrolytic process.

The recent electrochemical work was carried out by D. N. Craig and W. J. Hamer, with the assistance of Catherine Law and J. I. Hoffman. In essence, they determined the electrochemical equivalent of silver by measuring the mass dissolved by one coulomb of electricity. This, together with the atomic weight of the silver used in the experiments, gives the new value of the faraday.

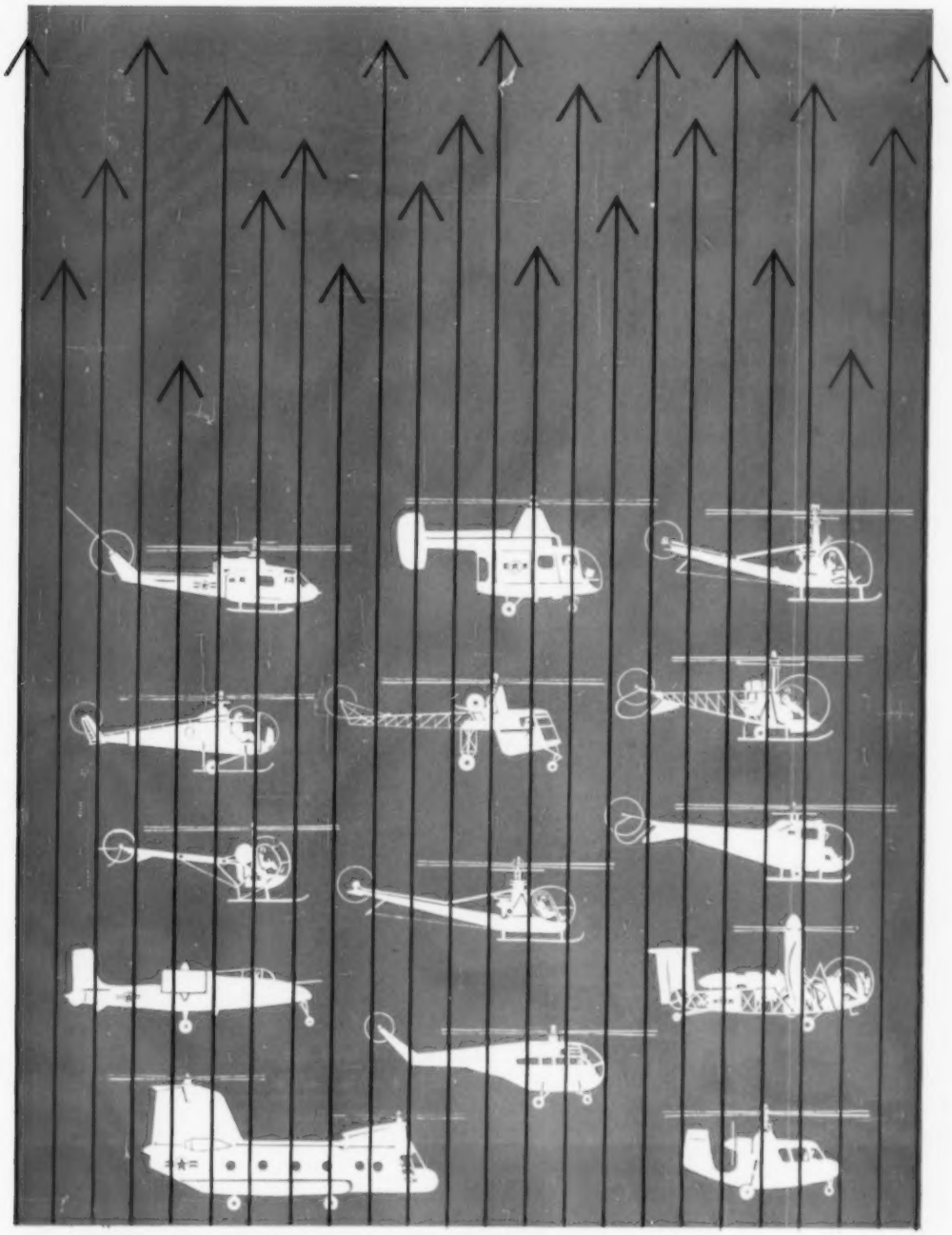
Preliminary values indicate that the faraday is 96,516.4 plus or minus 2.0 coulombs per gm. equivalent on the physical scale or 96,489.9 plus or minus 2.0 coulombs per gm. equivalent on the chemical scale (using 1.000275 as the conversion factor). The increased accuracy in the faraday afforded by this new evaluation is of major importance in both physics and chemistry where the faraday enters into the determination of other fundamental constants.

Mapping by Radar

A side-looking, all-weather radar that produces aerial maps of thousands of square miles of terrain per hour has been developed for the Air Force by Texas Instruments Incorporated of Dallas, Tex. It will give field commanders near-photographic, up-to-the-minute information on troop and material movements behind enemy front lines, and pinpoint targets over wide areas.

The new mapping radar, designated AN/APQ-55 by the Air Force, fills a need for complete, detailed tactical information on a round-the-clock basis, penetrates camouflage, and "sees" through rain or fog with little or no degradation of the final pictures.

In the APQ-55 radar, the perspective of distance is adjusted electronically so that items at the edge of the photo are of the same scale as those at the center. On an aerial photograph, ground distances become compressed in perspective



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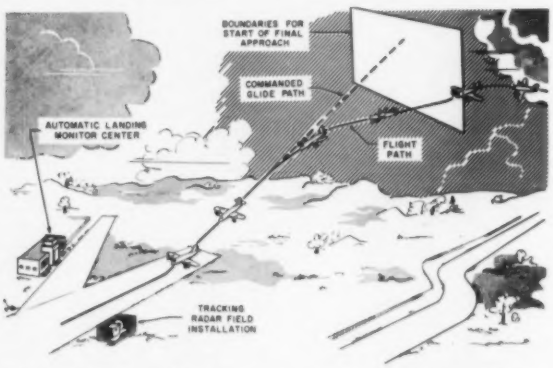
as the distance from the camera increases. Also, an aerial camera scanning a fixed angle will map less area as altitude decreases. However, the new radar system scans a constant ground area independent of the altitude of the aircraft and can cover a wide area at low altitude, recording terrain features in fine detail with no perspective distortion.

Automatic Landing System

An automatic aircraft landing system capable of landing two airplanes a minute during adverse weather is being evaluated by engineers of the Federal Aviation Agency at the National Aviation Facilities Experimental Center, Atlantic City, N. J. The system, developed for the U. S. Air Force by the Avionics Division of Bell Aircraft Corporation, Buffalo, N. Y., uses radar to



Automatic all-weather system can land two planes a minute.

track the airplane and radio to transmit control instructions to the plane's automatic pilot.

Described as the most modern, all-weather, automatic landing system in existence today, it may be integrated into traffic-control systems at high-density airports or operated as a landing aid at underdeveloped airfields.

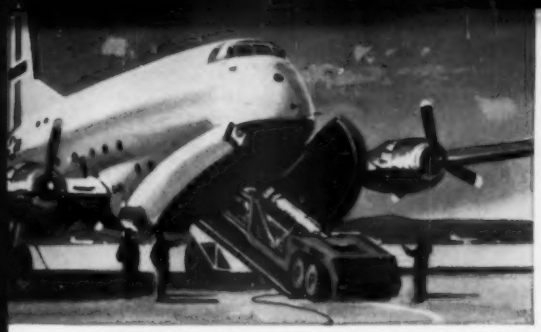
To land an inbound airplane, the precise tracking radar "locks on" the plane when it flies through an electronic window or gate from two to four miles from the end of the runway. At this point the pilot relinquishes control of the airplane to the system. Should the airplane be too high or too low, too far to the right or too far to the left, corrections are transmitted to the plane's automatic pilot. The airplane appears as a small dot on the radar screens in the operations trailer, permitting the monitors to check its position in relation to the desired altitude and the center of the runway.

Unlike other existing automatic landing systems, this one needs no complex electronic equipment in the airplane other than the standard autopilot and instrument landing system. A small aluminum corner reflector, designed to strengthen the reflected radar signal, is the only item which has to be installed on the airplane.

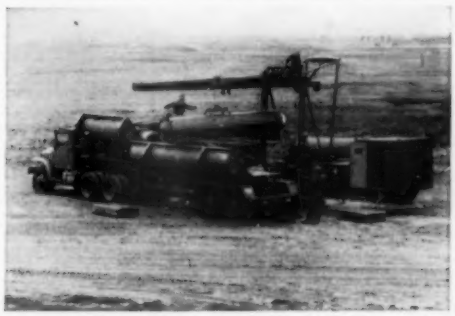
New Army Tear Gas

Development of an improved tear gas, so effective that those who have tested it rarely are willing to try it twice, was revealed recently by the Department of the Army. The gas causes no permanent injury, and its effects wear off quickly in fresh air. It has not yet been given a name.

The gas causes severe burning and watering of the eyes, irritation of the respiratory passages, a burning sensation on moist areas of the skin, painful forced coughing, and involuntary closing of the eyes. The gas can be delivered in a grenade that disperses it either as a smoke cloud or in aerosol form, or it can be delivered by any of the devices used to spread conventional tear gas. Used as a training aid, or to test the fit and performance of protective masks, it is prepared in a gelatin capsule.



AIR TRANSPORTABLE MISSILE. Sergeant can be flown to battlefield area. A supersonic, medium range, ballistic guided missile, it is 30 feet long and 31 inches in diameter.



QUICKLY ASSEMBLED IN THE FIELD, missile can be emplaced and fired by small crew under all conditions of weather and terrain. Simplicity of entire concept—including solid fuel propulsion—makes it an extremely efficient tactical weapon.

ON TARGET ON TIME, Sergeant is built in four pre-fab sections—payload, guidance, powerplant and fins. The precision inertial system is invulnerable to any known means of countermeasures.

FINAL TEST STAGE AT SPERRY—Sergeant missile must pass severe tests under static and dynamic loads as well as elevated temperatures due to high speed flight. Components are "proof-tested" in one of nation's most advanced environmental laboratories.

Readying the "Sergeant" for front line duty

Engineers prove U. S. Army's versatile artillery missile and its undeviating guidance system in strenuous tests

ONE OF A SERIES:

THE STORY BEHIND THE STORY
of Sperry's Utah Engineering Laboratory

A battlefield missile must be simple, foolproof, reliable, tough. Sperry Utah has the assignment of insuring that the Sergeant—latest in the Army's guided missile arsenal and successor to the Corporal—will be all these and more when it becomes operational.

Sperry has assisted in the Jet Propulsion Laboratory's development of Sergeant. Sperry has the prime contract for production of the missile system together with its launcher and its servicing-handling-maintenance equipment. First production is now under way at Salt Lake City.

The Sergeant can be transported by sea, surface or air. It will give increased fire support—both nuclear and non-nuclear—to forward deployed forces and to STRAC. In addition to its highly accurate and reliable guidance system, Sergeant incorporates "drag brakes," the latest development in range control for solid-fueled missiles. Coupled with the Thiokol power plant, the brakes aid in pinpoint battlefield aiming.

The Sergeant program is one of a number of projects going forward at Sperry Utah—projects which include classified work in advanced infrared systems among others. Here, as in every other area of our environment, Sperry is contributing significantly to America's progress in defense. Sperry Utah Engineering Laboratory, Division of Sperry Rand Corporation, Salt Lake City, Utah.

SPERRY

MATERIALS PROGRESS

George S. Brady

Synthetic Rubber Progress.—Synthetic natural rubber, chemically known as polyisoprene, appears now to be moving off the dead center which has delayed its commercial advance for several years, and this will undoubtedly affect the whole position of synthetic rubbers in relation to natural hevia rubber.

For a long time the ratio of synthetic rubber consumed in the United States in relation to total rubber consumed has remained almost stationary at just below two-thirds. This year the trend is again upward. The Rubber Manufacturers Association estimated that the 1960 consumption of rubber would be 1,665,000 long tons, of which 67 per cent would be synthetic, but later figures show a higher percentage of synthetic use.

Discussion concerning competition with natural rubber does not normally embrace the specialty rubbers which are relatively high in price and have physical characteristics with which natural rubber cannot compete. These rubbers remain well below 20 per cent of the total. Nor does it include the silicones and the urethanes that are more properly classified with plastics.

About 83 per cent of total synthetic consumption in 1959 was SBR, or styrene-butadiene rubber, a copolymer that can compete directly for many large-scale uses at a lower price.

But SBR has been a partial replacement rather than a substitute for natural rubber. There are at least 150 distinct types of this rubber on the market, but none of them have the tack, elasticity, and curing qualities of the natural rubber, nor is it likely that certain of the desirable rubber characteristics can be obtained with copolymers.

Polyisoprene $(C_5H_8)_x$, or "synthetic natural" rubber, has been produced for several years in small quantities, and there has been much effervescent talk of its replacing natural rubber entirely as soon as production costs can be reduced. But there is a big difference between the ebullience of the economist and the cold calculation of the scientist, and the delay in building large-scale production plants for this rubber has not been merely a matter of costs.

In fact, several methods have been worked out for producing the isoprene monomer, C_5H_8, from petroleum products at a competitive price by extracting the amylene, C_5H_{10}, and dehydrogenating it, by reacting the butylene, C_4H_8, with formaldehyde, or by catalyzing other CH groups from the refinery stream.

But it was not entirely clear that synthetic natural, or isoprene rubber, was the ultimate answer. Natural products are not always the best. Nature merely points the way rather than giving ultimate products, and natural rubber has some industrial shortcomings, especially its irregular quality and its poor aging properties.

The possibility of producing other natural-type rubbers of more desirable characteristics from the many monomers obtainable from petroleum had to be investigated by the researchers before launching into the single direction of isoprene. Isoprene is a methyl butadiene, not differing greatly from the butadiene, C_4H_6, used in producing the SBR copolymer rubber, and butadiene can be polymerized into an entirely new rubber with attractive characteristics. At least two companies, *Goodrich* and *Firestone*, are now going ahead with plants to produce both polyisoprene and polybutadiene rubbers. But this is by no means the end of the research road.

There was a time when the term rubber meant only one thing. But today, no one rubber can meet all the varying industrial-use requirements. Research is continuing in developing new rubbers and in perfecting polyisoprene synthetic-natural rubber, and the research is tied in closely with the alert and growing plastics industry.

Ethylene, C_2H_4, and propylene, C_3H_6, polymerize to form plastics, but the two together copolymerize to form rubbers. Cyclopentadiene, C_5H_6, also polymerizes like isoprene, and there are many other avenues of approach to desirable new rubbers.

Rubbers and Plastics.—There is no sharp dividing line between rubbers and plastics. Elasticity is usually the guiding factor in designating a rubber, and many plastics, which the chemists call "elastomers," have sufficient elasticity to meet certain use needs while also having other more desirable properties.

For example, the Lycra of *Du Pont*, and the Vyrene of the *U. S. Rubber Company*, employed to replace rubber in flexible garment fabrics, are urethane fibers. They have advantages over rubber in having better dyeing qualities and greater durability.

To the question as to how many different rubbers we will have, the only answer is that the number of possible varieties and grades is infinite. Research into new polymers is only one phase of the laboratory work. Important physical differences in the rubbers are also obtained by variously cross-linking the molecular chains or otherwise chemically altering the basic polymers. Varying the compounding also produces products of different characteristics.

Then there are the engineering design changes that can be made to utilize each rubber to its best advantage in any given product. An example of the latter can be seen in the new Air-Float tire of the *Gates Rubber Company*. This tire is made entirely from an SBR cold rubber with a nylon plastic cord, but it is claimed to give a 25 per cent increase in mileage largely by means of a low-profile design that provides wider tire wear surface on the road and reduces sidewall flexing.

Thus, many new vistas of advance appear ahead for synthetic rubbers, and the use of synthetic rubber will increase percentagewise. Furthermore, it is also quite certain that in case of a national emergency all essential industrial and military needs could be met with domestic synthetic rubbers. Actual present capacity of American synthetic rubber plants is 1,685,000 tons, not counting the capacity for polyisoprene and other new rubbers already projected.

Nevertheless, because of the greatly increasing over-all total use of rubber, and the increasing attention to the betterment of the quality of tree-grown natural rubber, it is quite certain that the demand for natural hevia rubber will continue large.

Presses for Aluminum.—Another step in bringing the aluminum can into full price competition with the conventional tinned or lacquered steel can is the introduction of improved high-speed impact

(Continued on p. 930)

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

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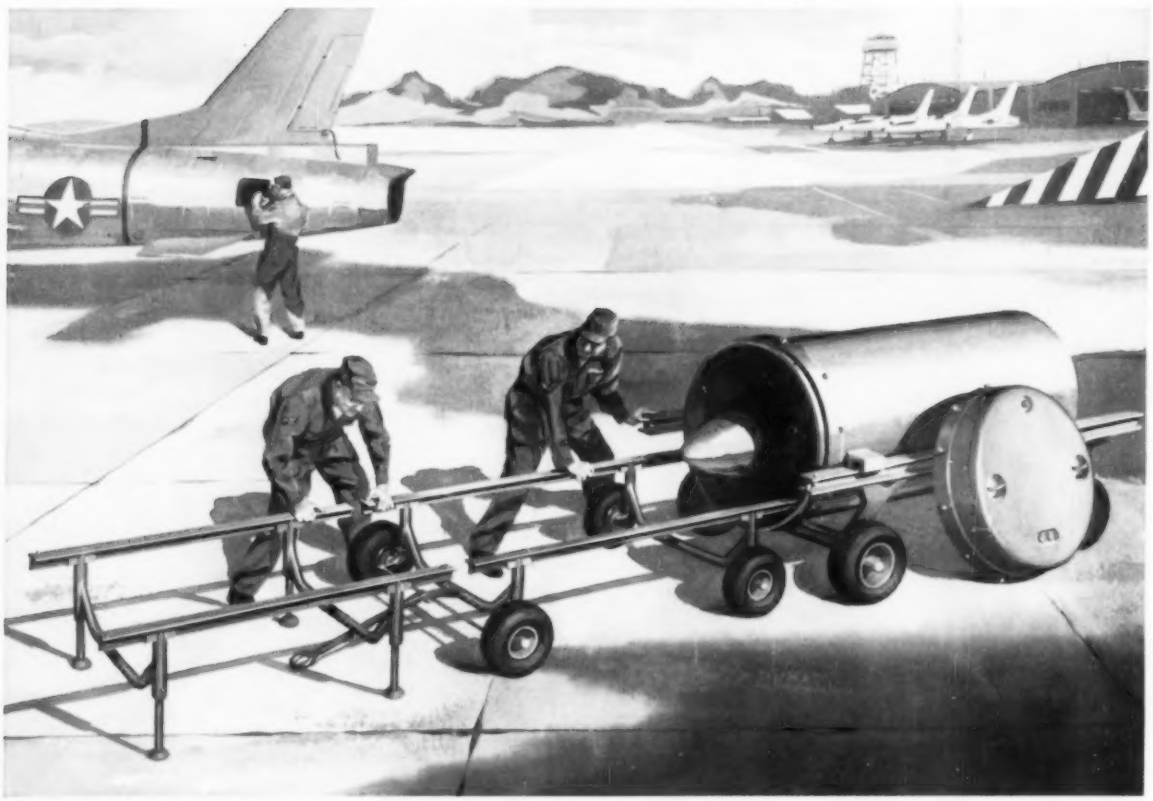

Shown as a working combination are three new products of American Electronics' Ground Support Division:

A featherweight 105 lb. transportation trailer capable of carrying loads up to 2500 lbs. such as the new light engines for aircraft, helicopters and drones; missile sub-assemblies, instrumentation packages, nose cones and other components. With 30″ track, rail stops, couplings, towbar.

A featherweight maintenance stand—a matching unit that hooks up with the trailer—weighs only 55 lbs. yet supports 1¼ tons. Although 6 ft. in length, 24 inches in height, and standard 30-inch rail gauge, this light, versatile stand can be easily carried and handled by one man.

A revolutionary new lightweight shipping container for engines, missile and aircraft components, 40″ in diameter, 80″ in length. This rugged, light container fits standard USAF trailers—is made of a rigid, heat-formed, expanded material for maximum protection and ease of handling.

These new units are examples of a long line of universal design developments by the Ground Support Division of American Electronics. Years of such experience has established American Electronics' leadership in the field of ground support equipment and systems for missiles and aircraft.

Please write for complete details on the above support units and for our new 24-page brochure on Ground Support Equipment.

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GROUND SUPPORT DIVISION

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Houdaille Rotary Hydraulic Shock Absorbers contain no external working parts. Many variations in valve arrangements provide specific torque to meet any damping requirements.

Houdaille Friction Snubbers provide "universal joint" action to accomodate any changes in the angularity of the snubbers. Just the right combination of material in the lining and barrel guarantees uniform frictional resistance.

4 reasons why you should specify

HOUDAILLE

Ride Control Devices

for every wheeled or tracked vehicle

1 Rotary Shock Absorbers and Friction Snubbers by Houdaille are built to take rough punishment. This is no idle boast. Life cycle tests of 6,500,000 cycles produce negligible wear on working surfaces of Shock Absorbers. In the field, the rugged construction of strong castings and forgings stands up under severe ride conditions. On commercial applications, both types of units are guaranteed for 100,000 miles. Both types are, of course, qualified for military vehicle use.

2 Rotary Shock Absorbers and Friction Snubbers by Houdaille operate throughout the full temperature range of −65° to +160°F. This factor is particularly important for military vehicles which may see service in any part of the world. To achieve this greater temperature adaptability in its Shock Absorbers, Houdaille uses a dyester blend silicone base fluid. The excellent lubricity of the fluid actually serves to extend the life of the unit.

3 The Rotary Shock Absorbers are hermetically sealed. Dirt, dust and mud will not affect either the Shock Absorber or the Snubber. You can even operate them under water.

4 Rotary Shock Absorbers and Friction Snubbers by Houdaille are easy to service and repair. They can be disassembled after long service life to replace seals. Shock Absorbers have an externally adjustable orifice to regulate damping torque, and a removable plug for periodic inspection of fluid level in replenishing chamber.

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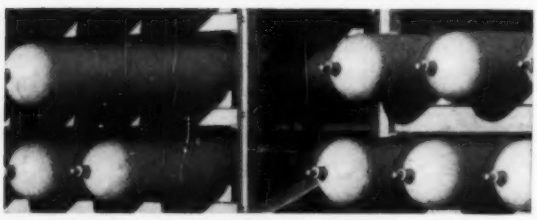

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Materials Progress (Contd.)

extrusion presses. A press built for the *Adolph Coors Company* by the *E. W. Bliss Company*, Canton, Ohio, has an eccentric crank action instead of the older knuckle-joint action. A compact 400-ton single-action press produces 120 eleven-ounce beer cans a minute from blanks fed automatically from a hopper.

The blanks are aluminum 2S, and are 2.5 inches in diameter and 1/8-inch thick, made by continuous strip casting. The one-piece can is 2.5 inches in diameter and 5.5 inches long. It has been estimated by the *Kaiser Aluminum & Chemical Corporation* that 25,000 tons of aluminum will go into can making in 1960—about 3 times the use in 1959.

Shallow-water Boat.—A new type of boat which *Airboats, Inc.*, St. Louis, Mo., is building for operation in shallow waters not navigable for boats with conventional propeller and rudder has the engine-driven propeller and the rudder completely in the air independent of the water. The whole construction is of lightweight high-strength aluminum alloys. The boat, which has a speed of 35 miles an hour, has 5 aluminum stringer keels on the bottom to protect it from injury.

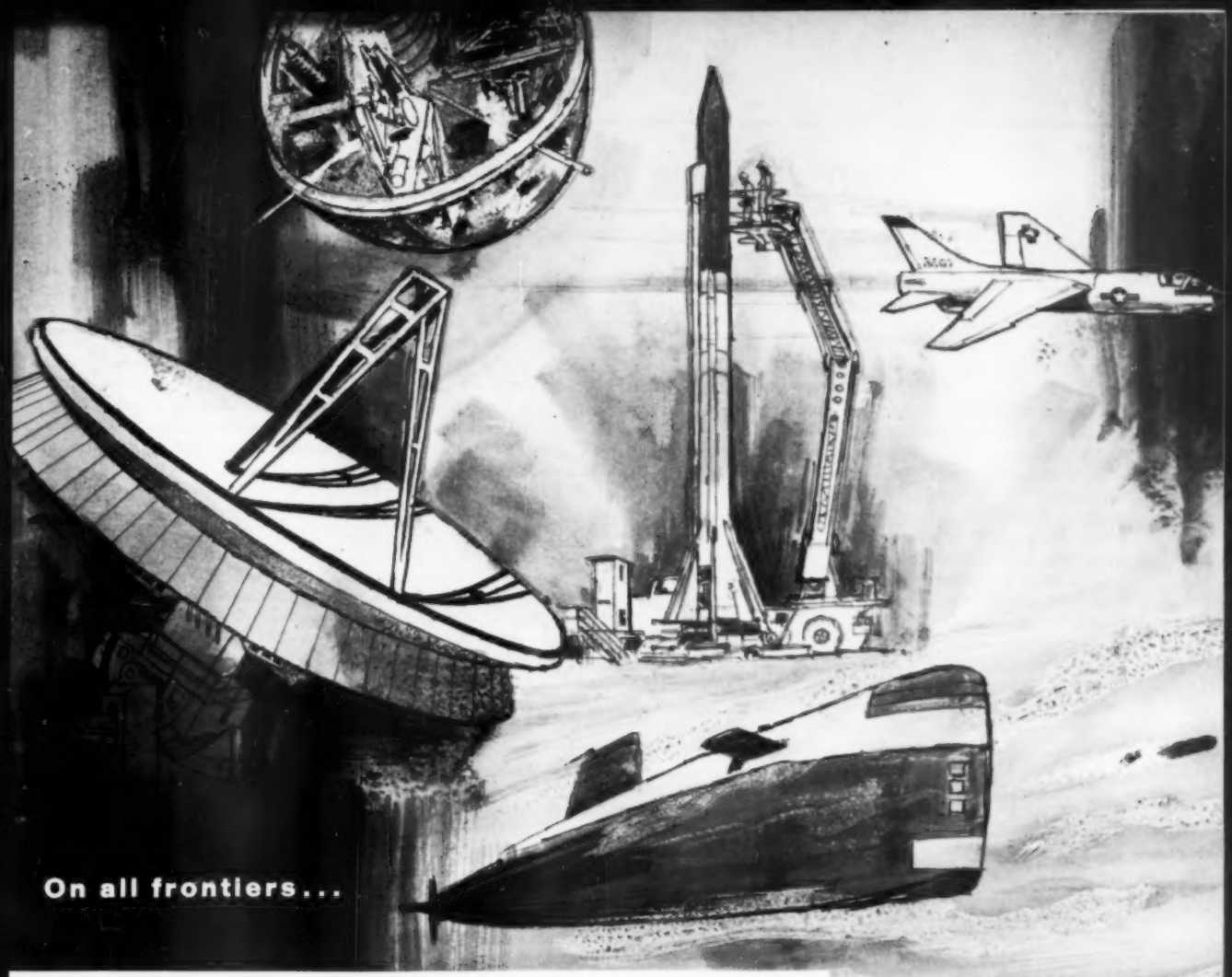
Seagoing Plastics.—Gleaned from the sales gossip at the 1960 National Motor Boat Show are these facts: Of the 375,000 pleasure boats to be built in 1960, about 150,000, or 40 per cent, will be made of reenforced plastic, about double the number of three years ago. Most of the 75 million pounds of plastic used for boat hulls will be polyesters. Sails are now synthetic fabrics, mostly nylon and Dacron. About 50 per cent of the cordage is synthetic, mostly nylon and Dacron fibers.

Miniature Connector.—*Amphenol-Borg Electronics Corporation* has a tiny electrical connector for multiline telephone "call directors" and for business machines with multiple low-voltage circuits that consists of fifty gold-plated cadmium-bronze contacts embedded in a molded Dapon (diallyl phthalate resin of the *Food Machinery and Chemical Corporation*) base. The housing, which is about the size of a small cigarette lighter, is of cadmium-plated brass with a clear chromate finish.

Nylon Conveyor Plates.—On conveyors for foodstuffs and other equipment where external lubrication is undesirable, the *Polymer Corporation*, Reading, Pa., advocates the use of extruded wear plates and other wear parts of nylon filled with molybdenum disulphide. The sulphide is evenly dispersed throughout the nylon, providing a uniform internal lubricant. The extruded parts have greater rigidity and better dimensional stability than ordinary nylon compounds, and have a heat resistance above 300 degrees Fahrenheit.

Utilizing Low-Grade Ores.—The Bureau of Mines also has been doing some noteworthy work on methods for utilizing low-grade ores and complex ores difficult to handle. It has recently developed a process for extracting tungsten of 99.9 per cent purity directly from impure scheelite. The one-step process consists in dissolving the ore in a fused alkali with added sodium chloride to flux the calcium oxide and then recovering the tungsten by electrolysis.

New Columbium Process.—*Kennecott Copper Corporation* has in the pilot-plant stage a process for the concentration of columbium from plentiful low-grade ores. It is a flotation process using a quinolinol flotation agent, and the company has been able to obtain a 10 per cent concentration of Cb_2O_5 from pyrochlore. This mineral is a complex of tantalum, columbium, sodium, and calcium oxides. Perovskite is another ore that may be used. In this mineral the metals are in a close-packed crystal lattice of barium and oxygen. Another complex mineral, called euxenite, contains a fairly high proportion of columbium-tantalum, normally difficult to extract.



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Alfred J. Zaehringer

Solar Satellite.—A new satellite of the sun, Pioneer V, has been placed into orbit by a Thor-Able rocket. The 90-foot-long, 3-stage vehicle weighed over 105,000 pounds at launch. Payload was a 94.8-pound ball designed to signal back data on radiation, cosmic rays, and magnetic fields in deep space. It is expected that signals will be received at distances of over 50 million miles. Each orbit around the sun will be about 506 million miles long, lasting some 295 days.

First stage of Pioneer V was provided by a Thor IRBM with a thrust of 165,000 pounds and a weight of 100,000 pounds. The second stage weighed 4,000 pounds with 7,500 pounds of thrust. A solid rocket of 500 pounds' weight and 3,000 pounds' thrust gave the payload a final escape velocity of about 25,000 miles an hour. A lifetime of about 100,000 years is predicted for the NASA space satellite.

Discoverer Discovered.—The "mystery" silent satellite, according to the Defense Department, is probably the recovery section of the Discoverer V launched last August. The section was in an orbit some 500 miles further from its launching Agena rocket. It is believed that the retrorocket kicked the pack into a higher orbit. The object has been under Navy radar vigilance for some months now.

Space Timetable.—NASA has just published its space timetable. Over the next 10 years a total of 260 vehicles will be fired. This averages about two launches a month and includes test firings of booster and upper stages, satellites, deep space probes, and manned flight around the earth and the moon.

Largest individual spacecraft sizes (in pounds of weight) are: by 1962, 8,000; by 1963, 30,000; by 1964, 40,000; and 55,000 in 1967. All estimates are based on the use of chemically propelled solid or liquid rockets. The plans do not figure in work going on with nuclear rockets or ion, electric, or magnetohydrodynamic propulsion.

Liquid Oxygen.—Liquid oxygen, known as LOX, is still king of the liquid propellants. The Air Force reveals that it has turned out its millionth ton of the cold liquid. Over-all LOX capacity is over one thousand tons a day. Five Air Force LOX plants now supply 85 per cent of its needs. As more Atlas and Titan ICBM'S go into operational sites, more LOX facilities can be expected, and each ICBM base will have its own LOX plant. The 2-stage Titan, for example, is loaded with about ninety tons of propellant—both fuel and LOX oxidizer. Usual weight ratio of oxidizer to fuel is about 2:1.

Liquid Hydrogen.—Liquid hydrogen—for use with LOX—will probably shape up for large-scale applications in future rocket vehicles. Such large missiles as Centaur and Saturn now are being planned as all-hydrogen-fueled in upper stages. Estimates state that over $100 million has gone into preparing plants and facilities for producing and storing liquid hydrogen.

NASA has recently asked for bids on the construction of a LOX-liquid hydrogen engine of 165,000 pounds' thrust (this will later be up-rated to about 300,000 pounds). The present Centaur hydrogen engine is now rated at 15,000 pounds' thrust.

Other Fuels.—Storable liquid propellants are being looked on to ease the present difficult ground handling of the large liquid rockets. This is especially so in the rapid scale-up that has taken place in the solid-rocket area. Two propellants have been used which are in the storable category. It is believed that the Navy has been using nitric acid-amine fuel in the Bullpup missile which recently was switched from solid to liquid propellant. A similar combination was recently used on the Holloman AFB track where three rockets giving a total thrust of 114,000 pounds pushed a sled to a speed of over 1,600 miles an hour.

It now appears that the Titan ICBM may be modified to use storable nitrogen tetroxide oxidizer. The present countdown time of hours could be reduced to minutes.

Solid Propellants.—It appears that solid propellants are about to make a big break-through in the area of high-thrust rocket engines. The Air Force has decided to let industry develop a booster rocket of one million pounds of thrust. One objection formerly held for such large solid rockets had simply been that of handling a heavy and bulky loaded structure. Now solid rockets can be made in segments—much like slices of sausage—which can be easily transported from factory to launch site and then joined.

Boron fuels are now back in the picture. The Air Force is allocating $9 million for production of 300,000 pounds of pentaborane, and it is believed that the boron fuels will be going into rocket propellants. These fuels appear to offer greater rocket performance than the present hydrocarbon fuels. The borons are attractive, also, as fuels in solid rockets.

Missiles.—The Army Pershing solid-propellant missile—the ultimate replacement for Redstone—has been fired successfully at Cape Canaveral. The test version has a diameter of about three feet and a length of thirty-two feet. Only the first stage was tested, and the flight was about twenty miles. The actual tactical missile will be about the same size but with two stages which will allow for firing at different ranges.

Meanwhile, the first full-scale firing of a Polaris Navy IRBM with inertial guidance system covered a distance of some 900 miles.

An air-launched ballistic missile, Skybolt (GAM-87A), will be developed for use on the B-52. The rocket would carry a nuclear warhead, have two stages, and be solid-propelled. Range would be 1,000 to 1,500 miles. Such air-launched missiles would further strengthen the punch of bombers.

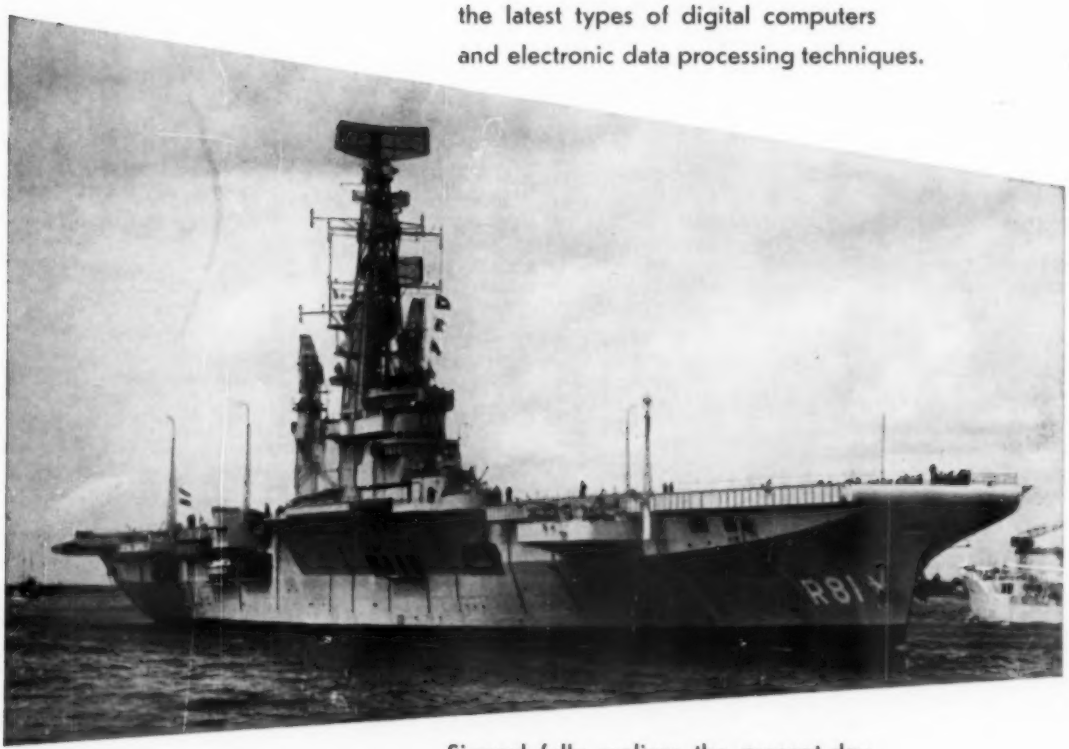
The Atlas, originally planned for "soft" sites, will be emplaced in hardened launch facilities. About one-half of the thirteen Atlas squadrons now planned will go underground. The other ICBM, the Titan, recently made a 5,000-mile flight from Cape Canaveral. A major feature of the successful flight was the instant ignition and operation of the 80,000-pound-thrust second-stage rocket engine.

Thor Progress.—The Air Force will soon begin a new series of research and development tests of the Thor IRBM modified to increase Thor's versatility and equipped with a modified liquid-fuel rocket engine to deliver more thrust. Besides the more powerful engine, the Thor will get a new silhouette—longer than the normal Thor which is now operational with the RAF units in England.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

SIGNAAL

SIGNAAL produces a wide variety of complex electronic and mechanical equipment. The emphasis throughout is on the design of complete systems rather than on disconnected units. The principal products of the company are automatic weapon control systems, radar systems, and the automatic air traffic control system SATCO, using the latest types of digital computers and electronic data processing techniques.



Signaal fully realizes the present-day need for complete integration of warning and fire control equipment to make the best use of all available weapons. The company is now able to offer automatic and integrated naval weapon control systems providing long range warning, aircraft control, target indication, and fire control against air, surface and underwater targets.

N.V. HOLLANDSE SIGNAALAPPARATEN Hengelo — Netherlands

ARMAMENT ELECTRONICS

W. H. Van Vliet

Microwave Computer Link.—North American Aviation has installed a microwave link to transmit data from its Rocketdyne Division in Canoga Park, Calif., to a system of six IBM computers at the company's main plant at Los Angeles International Airport. The plant also will be linked by microwave with its Autonetics and Missile Divisions in Downey. This is reportedly the first time an installation of this type has been made.

Cosmic Radiation Measurements.—Plans have been made by the Navy to launch two Skyhook balloons to measure high-energy cosmic radiation at altitudes of 100,000 to 120,000 feet. The balloons, developed by Winzen Research, Inc., will be launched in the Caribbean with about 2,500-pound payloads including approximately 800-pound blocks of emulsion sheets to measure cosmic radiation.

Defense Electronics Expenditures.—The Commerce Department's Business and Defense Services Administration has estimated that military electronics sales, already up 17 per cent in 1959, will increase 15 per cent in 1960. This increase is expected to bring electronics sales to about $10 billion by 1960.

Gallium Phosphide Diode.—A gallium phosphide diode, capable of withstanding temperatures of up to 1,500 Fahrenheit, has been developed by the Army Signal Research and Development Laboratory. Before a development program is begun, research will continue on basic material properties.

Photoscan.—A new military reconnaissance electronic system than can transmit images from unmanned airborne vehicles has been developed by CBS Laboratories. The system, called "photoscan," can transmit to an airborne relay station or to ground receiving equipment. Photoscan incorporates a resolution of more than 10,000 lines, as compared with over 500 for conventional television techniques. Some reconnaissance systems depend upon the retrieving of film, but, with photoscan, physical retrieval of the film is unnecessary, thus achieving both high speed and convenience.

Interplanetary Homing System.—Scientists of the Lockheed Missiles and Space Division have described a homing system designed to go into operation when an interplanetary spacecraft approaches its cosmic destination and to steer it automatically to a safe entry. The system would go into operation when the spacecraft, with moderate precision, got within 400,000 miles of its destination. The system's main advantages are its great accuracy and the fact that it reduces the need to rely solely on the accuracy of the primary launch guidance system. The instrument package reportedly can be built from currently available components.

Air Ground Telephony.—The Federal Communications Commission will authorize expansion of public air-ground radiotelephone service for airline passengers and general aviation. The expansion will provide coverage through new ground stations at Newark, Washington, and Pittsburgh. It should be possible by early summer for passengers aboard aircraft equipped with radio-telephone sets and flying along the major air routes of these cities to reach almost any spot on the earth by telephone. The service is already in trial use in Chicago and Detroit areas and has proved very popular with business aircraft operators and passengers in planes equipped with radio-telephone sets.

HF Radar.—The Navy has developed a new type of radar that may be capable of detecting low-flying aircraft and submarine-launched missiles at distances of more than 2,000 miles. A prototype installation at Chesapeake Beach, Md., is scheduled for completion late this year. The radar was developed in a program called Project Madre, and uses the same 3-to-30 mc. HF as a previous missile launch detection technique.

In this band, signals bounce off the ionosphere and back to earth, unlike conventional radar systems which operate on ultrahigh and microwave frequencies which are limited to line-of-sight ranges. A disadvantage of the HF band is the variable propagation and the fact that it is relatively easy to jam. To make the system insensitive to changing ionospheric conditions and the ocean waves, it will be gated so that only targets exceeding 50 m.p.h. can be detected.

Atomic Radiation Detector.—A new detector, called a "solid-state ionization chamber," has been developed by Hughes Aircraft Company. The device is an innovational radiation detector, and its development combined the efforts of nuclear and solid-state physicists. The miniature device, smaller than the head of a pin, may find wide use in space exploration, military, medical, and nuclear power control. The unit's advantages over present detectors are small size, low operating voltage, and high speed. Operation is based on an extremely thin slice of doped silicon which emits pulses when hit with nuclear particles. These pulses are then measured and analyzed, providing all required information. Developers of the detector report that the device is so simple it is surprising scientists have not been able to develop it before.

Optics for Space Use.—The Air Force is sponsoring research on optics for space use. Main interest is in communication and radar systems for extraterrestrial space where conditions do not limit the use of the optical portion of the frequency spectrum. Use of optics may provide long range, excellent security, good accuracy, and possibly low cost. The system, called Lidar (light detection and rangiag) would consist of an optical maser and suitable modulator and a receiver with a maser preamplifier, a lens for focusing the returned light, and a photodetector.

Thermoplastic Recording.—Developmental work on a thermoplastic recording technique, for use in systems where weight and size reduction is important, is being done by General Electric Company. The recording technique combines the bandwidth, processing speed, and versatility of magnetic recording with the storage capacity and resolution of photography.

Application for the new technique may be in military and traffic-control radar, data storage, and satellite surveillance.

Lieutenant Colonel Van Vliet, U.S.A.F. (Ret.), formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is an electronics systems engineer in the California Division, Lockheed Aircraft Corporation, Burbank, Calif.

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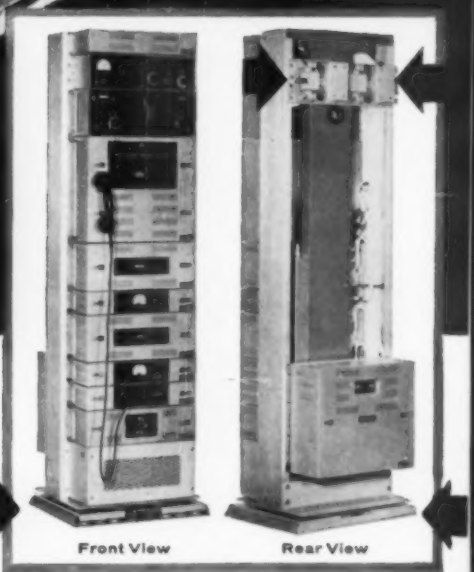

This is Robinson Model W664-3 with the Collins AN/URC-32 single sideband shipboard transceiver installed. This all-metal mounting system includes a heavy duty, dual stage base and a stabilizer unit which is mounted on the rear of the equipment.

Exclusive dual stage concept and highly damped MET-L-FLEX® resilient cushions assure the full range of vibration isolation and shock attenuation—double protection for extra reliability! *Send for FREE brochures.*

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SPACE ARMAMENT

Javelin Research Series

Air Research and Development Command personnel recently launched a Javelin rocket 670 miles into space ending a series of Air Force radiation experiments at the National Aeronautics and Space Administration's Wallops Island Station in Virginia.

Information collected by the rocket's instruments included measurements of the radiation belts surrounding the earth, mechanisms which keep the radiation in place, and additional information on the origins and lifetimes of the charged particles of which the belts are composed.

Conducted by ARDC's Air Force Special Weapons Center, Albuquerque, N. Mex., the Javelin project began July 7, 1959, when a 45-pound package of scientific instrumentation and telemetry equipment reached an altitude of 600 miles. The unguided 49-foot-long, 7,300-pound, solid-propellant Javelin rocket consisted of Honest John, Nike, and Vanguard components.

To provide mobility of sounding operations and to eliminate the need for launching pads, the Special Weapons Center presently is testing an air-launched rocket system and has 29-foot Jaguar rockets under development for vertical launch to above 500 miles by B-57 jet bombers.

Photographs from Space

Tiros I, the U. S. experimental meteorological satellite, after its first full week in orbit had accomplished 101 trips around the world at an altitude of about 450 miles and had transmitted hundreds of cloud pictures electronically to ground receiving stations at the Research and Development Laboratory of the U. S. Army Signal Corps, Fort Monmouth, N. J., and at the Kaena Point station in Hawaii, operated by Lockheed for the Air Force.

The two TV cameras in Tiros differ in coverage and resolution. The wide-angle camera, at 400 miles' altitude, is designed to cover an area of clouds roughly 800 miles on a side. The narrow-angle camera will photograph a smaller area located within the wide-angle camera's view. Photos taken by the narrow-angle camera cover eighty miles on a side.

Identical except for lens equipment, the cameras are both the size of a water glass and use a half-inch Vidicon tube especially designed for satellite use. Each camera consists of two parts: a Vidicon and a focal-plane shutter which permits still pictures to be stored on the tube screen. An electron beam converts this stored picture into a TV-type electronic signal which can be transmitted to ground receivers.

Connected to each camera is a magnetic tape recorder. Out of ground-station range, Tiros can record up to thirty-two photographs on the storage tape for later relay, or picture data from the cameras can by-pass the tape and be transmitted directly to the ground when the satellite is within range of a station. The Mylar-base tape is 400 feet long and moves 50 inches a second during recording and playback. The two TV systems and their

Undersea launch pad for sixteen Polaris

associated equipment operate independently of one another.

Photo data are transmitted from one camera at a time. Tape readout from both cameras will take 3½ minutes. The satellite will be within transmission range of ground stations up to 12 minutes. Connected to each photo system is a 2-watt FM transmitter operated at a nominal frequency of 235.00 mc. which will relay picture information on command to ground stations.

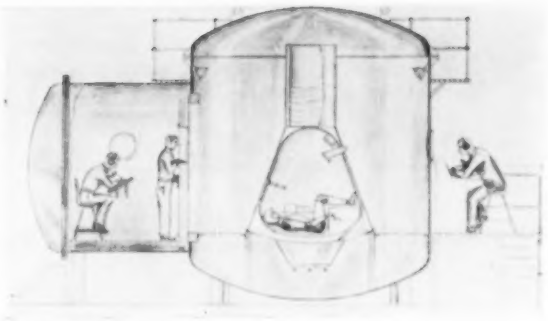
The Tiros experiment was designed specifically and solely to obtain widely dispersed cloud-formation photographs of sufficient photographic sharpness, both from the wide-angle and narrow-angle cameras, to identify clouds which, because they reflect the sun, could be expected to show up well. The system was not intended to pick up detail on the earth, which shows up on the photographs darkly in comparison with the clouds.

Space Simulator

American astronauts will slip into space without leaving the launching pads of Cape Canaveral, Fla., by means of a huge altitude simulator being built by Tenney Engineering, Inc., Union, N. J. The tank, an extremely high altitude chamber ordered by the National Aeronautics and Space Administration for Cape Canaveral, will accommodate the Project Mercury capsule in which the Nation's first space travelers will be launched into orbit. It will simulate an altitude of 225,000 feet with dive rates so that the astronaut and his space vehicle will function as if they had been hurled aloft and were returning to earth.

The astronaut, flat on his back with his knees cradled in a sitting position, will be linked to the outside world by a man-made umbilical cord containing the oxygen and intercom systems and a myriad of test control signal conductors. Windows and ports in the high-altitude chamber will enable doctors and others to view reactions in the simulated void.

The chamber holding the Mercury capsule will be twelve feet in diameter and fifteen feet high. The capsule itself will be lowered into it through a top lid. An adjoining air-lock or anteroom



High-altitude test chamber

will simulate an altitude of 45,000 feet and is for observation and safety entrance.

Special instrumentation will control the vacuum surrounding the capsule. Normal "diving" will be controlled from zero to 50,000 feet a minute, but in an emergency the chamber will be capable of reaching sea level from 225,000 feet in 6 seconds.

Joint Atmospheric Study

The National Aeronautics and Space Administration recently announced that as a part of a cooperative program it will conduct studies of the upper atmosphere with the Space Commission of the Italian National Research Council.

The program will be carried out with sounding rockets from an Italian launching site on Sardinia. It is hoped the launchings may be coordinated with the International Rocket Week.

According to the understanding reached by the two organizations, the Italian Space Commission will provide the rockets and launching facilities, and the NASA will furnish the payloads.

missiles

A U. S. Navy Polaris submarine is a self-sufficient missile base. It provides comfortable quarters for its hundred-man crew and carries supplies for several months. In its launching tubes—eight on each side, as shown in this cutaway model—will nest 16 Polaris missiles. But a Polaris sub differs from all other missile bases in one important respect: it can disappear from the face of the earth for weeks at a time. Though its position in ocean depths will be unknown, its presence will be felt. For—should America ever be attacked—each Polaris sub could launch its 16 Polaris missiles in as many minutes. Lockheed is prime contractor and system manager for the Polaris missile.

LOCKHEED MISSILES & SPACE DIVISION SUNNYVALE, CALIFORNIA

RECENT PATENTS

Compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.

Water-Resistant Explosive.—*U. S. Patent No. 2,908,560. Issued October 13, 1959, to Adolf Berthmann, Gotthard Kuhn, and Helmut Kaufer. Assigned to Dynamit Aktiengesellschaft vormals Alfred Nobel & Company:* This invention provides a noncaking water-resistant explosive of the ammonium-nitrate type. A second explosive compound, consisting of di- and trinitrotoluenes, imparts water resistance to the ammonium nitrate. A surface-active additive such as tetryl also is added.

The nitrotoluenes so arrange the ammonium nitrate crystals and so unite them to form rounded conglomerates under the action of the surface-active material that only a relatively small number of ammonium nitrate crystal faces remain uncovered.

Cartridge Guiding Device.—*U. S. Patent No. 2,907,251. Issued October 6, 1959, to Carl Gustav Ingemar Sahlberg. Assigned to Aktiebolaget Bofors:* This invention provides a device for guiding rounds of ammunition while being rammed into the cartridge chamber of a gun, which precludes a damaging contact between the round and the cartridge chamber and a wobbling motion of the round during its movement toward and into the chamber. The round, while moving toward the cartridge chamber, is deflected from contact with the entrance edge of the chamber. It is also subject to a springy restraint, thereby impeding wobbling of the round during the ramming operation.

Ram Air Bomb Ejector.—*U. S. Patent No. 2,905,055. Issued September 22, 1959, to Burton H. Camp and Richard G. Clarke:* This invention provides a bomb-release device which will release bombs from high-speed aircraft in a positive manner without danger of the bomb being retarded by the slipstream of the aircraft. The slipstream is, in fact, used to effect the release of the bomb, air being directed into the bomb chamber with a ram effect in such manner as to eject the bomb.

Projectile Cavity Charges.—*U. S. Patent No. 2,900,905. Issued August 25, 1959, to Duncan P. MacDougall. Assigned to the Secretary of the Navy:* This invention provides an improvement in the performance of projectile cavity charges by controlling the detonation wave upon a projectile conical liner so that its incidence is more nearly normal to the surface than that obtained in a conventional cylindrical charge. Improvement in performance is obtained by replacing the central core of the main cast pentolite filling with cast TNT or even an inert solid such as wood or paraffin. Improvement in depth of penetration is observed without significant decrease in the hole diameter.

Prolonging Balloon Flight.—*U. S. Patent No. 2,904,285. Issued September 15, 1959, to William F. Huch. Assigned to the Secretary of the Navy:* This invention provides a means for prolonging balloon flight. It provides for continuous slow reduction in weight of a ballasting system by absorption of thermal energy contemporaneously with continuous inherent gradual loss of balloon lift.

Fig. 1.

In Fig. 1 there is shown in flight a balloon 10 from which is suspended by a line 12 a box 14 which may contain telemetering instrumentation and material to be released automatically over a target area. The balloon is of the constant-volume type formed of a plastic film such as Mylar or polyethylene or other suitable material, and any suitable lift gas may be used.

The rate of leakage and diffusion of the helium through the balloon material is low and may be readily calculated for ideal conditions, and the loss of lift from leakage and diffusion under actual conditions from the experience of a number of flights has been determined with fair accuracy. In accordance with the present invention this loss of lift is compensated for fairly accurately by evaporation of a suitable substance 18 suspended from the balloon and held in a suitable container 20 having a vent 22. The container 20 is preferably a good heat conductor and may be colored as desired for absorption or reflection of heat and may be rigid or may be made of flexible material such as a plastic bag. The substance 18 may be water, alcohol, liquid air, or other suitable liquid which is evaporated under the conditions of balloon flight or it may be an evaporative solid.

Self-Destruction Device.—*U. S. Patent No. 2,900,906. Issued August 25, 1959, to Charles R. Olsen. Assigned to the Secretary of the Navy:* This invention provides improved percussion and self-destruction fuze means to ensure the self-destruction of warheads of projectiles after they have traveled a predetermined time without having first been exploded by contact with a target. It has been found that it is possible to initiate a shock wave at one end of a warhead which can travel through the body of the warhead and be utilized to cause firing in an armed fuze at the other end of the warhead if the fuze is of the shock-sensitive type, such as one utilizing a piezoelectric element.

Water-Discrimination Fuze.—*U. S. Patent No. 2,900,912. Issued August 25, 1959, to Henry D. Saunderson. Assigned to the Secretary of the Navy:* This invention provides a water-discrimination fuze which prepares a detonator within the fuze of a missile in response to the deceleration of the missile as it changes from a relatively high velocity in air to a much lower velocity in water.

Incendiary Projectile.—*U. S. Patent No. 2,900,914. Issued August 25, 1959, to Thomas Q. Ciccone. Assigned to Secretary of the Army:* According to the inventors, this invention provides an incendiary projectile which has a high degree of sensitivity and uniformity of functioning at long ranges, can successfully penetrate the target for which it is designed ninety per cent of the time, is drop safe from a distance of forty feet, bore safe in a worn tube at extreme temperatures, incorporates a maximum amount of incendiary mixture without reducing sensitivity, and which can be easily adjusted in sensitivity for the desired target.

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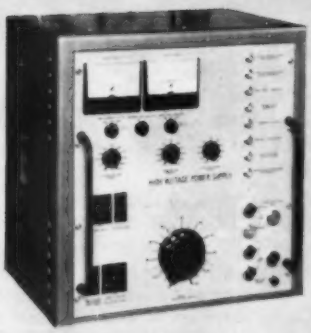

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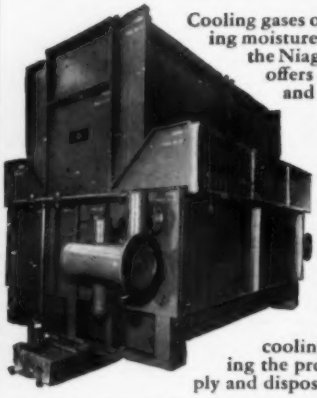

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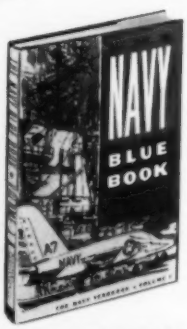

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

MAJ. GEN. E. P. MECHLING, *aviation ordnance expert, editor, Washington, D. C.*

COL. BENJAMIN S. MESICK, *engineer, educator, author, University of Arizona, Tucson, Ariz.*

PHILIPPE W. NEWTON, *aeronautical engineer, researcher, Los Angeles, Calif.*

RICHARD H. SFORZINI, *engineer, technical analyst, Redstone Arsenal, Ala.*

LIEUT. COL. S. M. SMOLENSKY, *engineer, Alexandria, Va.*

CAPT. J. M. P. WRIGHT, *naval ordnance engineer, logistician, editor, Washington, D. C.*

Dictionary of American Naval Fighting Ships. Volume I—1958. By Naval History Division, Office, Chief of Naval Operations. Washington: U. S. Government Printing Office. 349 pp. $3.

THE Naval Historical Branch is engaged in a tremendous project of great value to historians and of broad interest to all who follow naval affairs.

Rear Adm. E. M. Eller, Director of the Naval History Division, reports in the preface of this first volume that, including our continental Navy, there are a total of 10,000 ships to be recorded. He does not predict the number of volumes to be printed, but Volume I recounts only the history of all ships whose names begin with A and B.

What ship did you serve in, sailor? All the data are here—her characteristics, the background of her name with thumbnail biographies if named for a person, the shipbuilder, the sponsor, the first skipper, and an excellent brief on her service.

All the ships are here from the latest minesweeper, AFFRAY, commissioned in December 1958, to the ANDREW DORIA, a 14-gun brig, commissioned in December 1775, and the many odd types that served in the Civil War.

An appendix lists in chronological order the characteristics of all battleships, cruisers, submarines, submarine tenders, and destroyer types that have ever been built or authorized. For example, the evolution of cruisers is shown between the "protected cruiser, ATLANTA, commissioned July 1886" and the "nuclear-engined guided-missile cruiser, LONG BEACH (CG(N)9), keel laid December 1957." Later volumes will continue these lists.

This is a great start on a monumental undertaking that is welcomed by all sailormen and historians—and a best seller at the Government Printing Office.—J. M. P. WRIGHT.

My Life. By Grand Adm. Erich Raeder. Annapolis: United States Naval Institute. 430 pp. $6.

NOT only naval men, but officers of all military services will find this book worthy of study. The more one ponders the situation from 1939 to 1945, the more one marvels at what the Germans were able to do with only a tiny fraction of the resources available to the Allies. We won the war, but, as Gen. Matthew B. Ridgway said in his own story, we won it only against a people "whose spirit and confidence had been eroded away," for the

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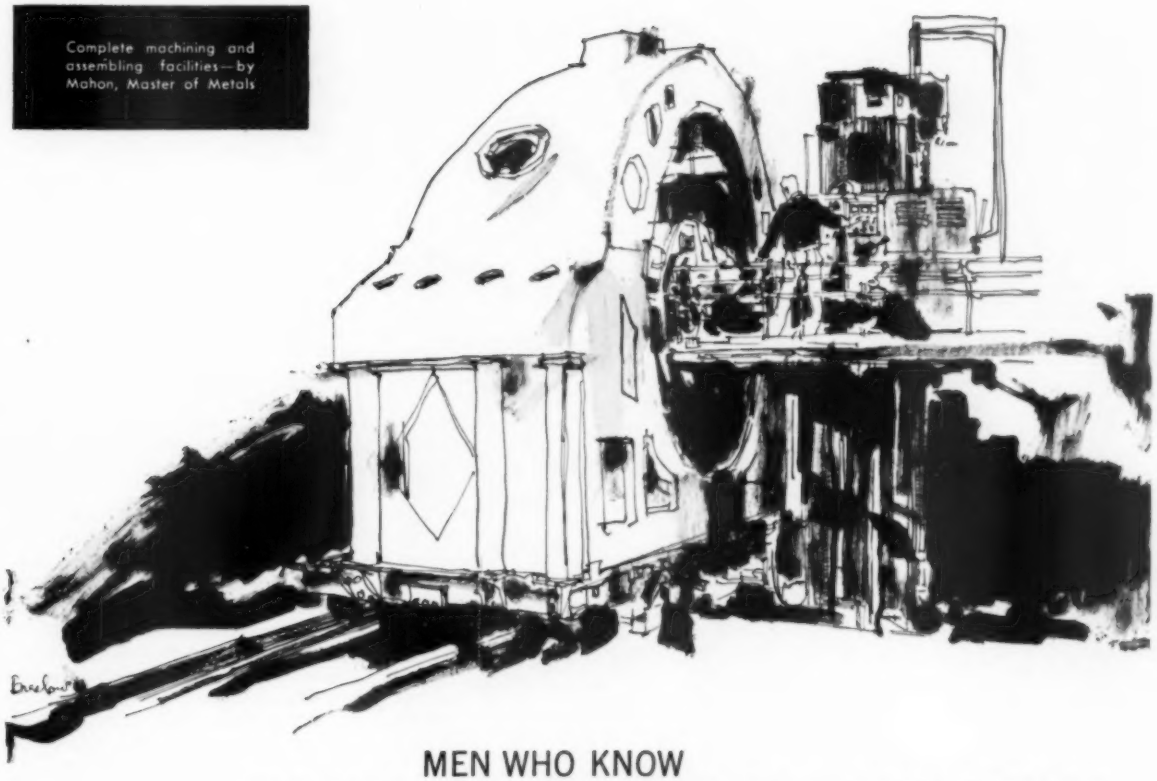

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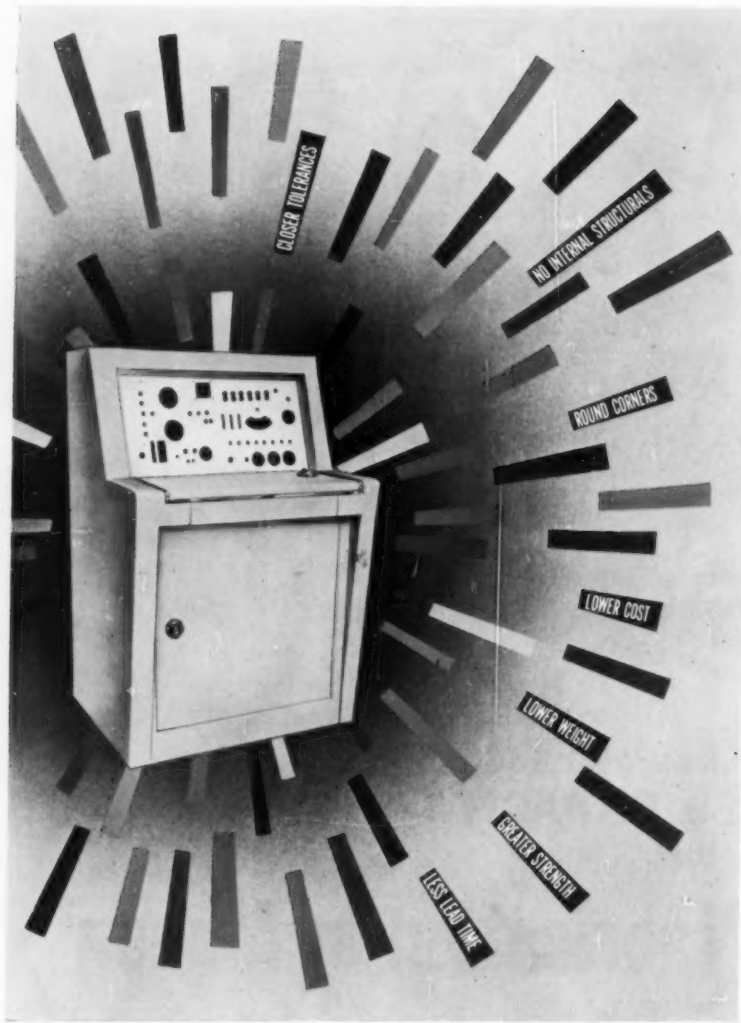

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Book Reviews (Contd.)

Germans had already buried their armies and their hopes in the snows of Russia.

The British and French had a ten-to-one superiority in naval ships when the war began and the advantage of an outer position to block off raw materials from German industries. In 1939 Germany had only fifty-seven submarines, and, because of the long distances they had to travel, the active combat ratio for the Germans was only one to seven instead of the usual one to three.

The book is more than an autobiography. It is a study of the long naval period from about 1890 through the two World Wars. It is something for today's military planners to think about, for Germany's failures did not come from lack of military and technical genius, but from lack of supplies.

One of the most instructive features of the book is Admiral Raeder's observations on the training of personnel. Maintaining that education depends upon the character of the educator, he exacted from his officers high standards that could be reflected in the enlisted men. He was a devout Christian and never a Nazi, and, in spite of the utmost efforts of lawyers at the Nuremberg trial to prove otherwise, the German Navy was completely exonerated from charges of violations of international law.

Every officer who is now a part of our program of preparing to wage "defensive war" should read this book and ponder on what sacrifices in nonessentials we will have to make if engaged in war against a major power and what personal political responsibility may be charged against the military officers by some future "tribunal."—GEORGE S. BRADY.

Rocket Propellant Handbook. By Boris Kit and Douglas S. Evered. New York: Macmillan Company. 354 pp. $12.50.

THIS handbook is a much-needed analysis and synthesis of the considerable amount of literature that has been compiled on rocket propellants over the past twenty-five years.

While confined to chemical propellant substances and restricted somewhat by security implications, this text presents much useful reference data on about one hundred chemicals which have possible use as rocket propellants.

The analysis of each substance covers general characteristics, physical and chemical properties, methods of storing and handling, and propellant performance characteristics.

This handbook should be of interest to all concerned with guided-missile technology, particularly the propulsion industry, the military ground-support-equipment industry, the materials-and-handling industry, and the facilities-construction industry.—S. M. SMOLENSKY.

Designs and Performance of Gas Turbine Power Plants. Edited by W. R. Hawthorne and W. T. Olson. Vol. XI, High Speed Aerodynamics and Jet Propulsion Series. Princeton: Princeton Univ. Press. 563 pp. $15.

WHILE this highly technical compilation of basic information in regard to the gas turbine as a source of propulsive power is unlikely to appear in a list of popular best sellers, it will fill a great need among practicing engineers and scientists for a source of present-day knowledge in the field of aircraft gas turbines.

For the complete treatment of the gas-turbine power plant, this volume should be used together with Volume X, "Aerodynamics of Turbines and Compressors," also edited by W. R. Hawthorne. The main subjects in Volume XI are combustion, mechanical and metallurgical aspects, and performance and control.

Only a glance at the table of contents of this publication is necessary to realize the wealth of experience which is back of the information collected and prepared during the period from 1952 to 1959 when research and development activity on gas-turbine power plants was at maximum levels. Among the contributing authors are well-known American scientists such as Hottel, Orowan, Soderberg, and Williams of M. I. T. and Radcliffe of Johns Hopkins. In addition to being one of the volume editors, Walter T. Olson of the Lewis Flight Propulsion Laboratory, NASA, prepared the section on "Combustion Chamber Development."

Other contributors from the same NASA Laboratory are Childs on "Flame Stabilization" and Scull, who was joined on "Mixing Processes" by Graves of the Nuclear Development Corporation of America. Another author from private industry is Louis C. Gibbons of the Ohio Oil Company who prepared the section on "Fuels for Aircraft Gas Turbine Engines."—B. S. MESICK.

Fundamentals of Guided Missiles. By the Air Training Command, United States Air Force and Technical Staff. Los Angeles: Aero Publishers, Inc. 575 pp. $12.50.

FOR many years now, the U. S. military services have been leaders in the field of scientific and technical education, as time and again they have been faced with the necessity of converting young men with widely assorted backgrounds into experts, skilled in such fields as electronics, nuclear physics, aeronautics, missilery, and photography. "Fundamentals of Guided Missiles," originally prepared by the U.S.A.F. Air Training Command and now available to the public, is an example of the excellent manuals that are but a few of the many aids used to train the men who are called upon to maintain and operate today's complex weapons systems.

In contrast with the large numbers of texts presently being published which assume a profound engineering or scientific background, this volume is aimed at the technician who, while possessing certain native abilities or aptitudes, has no mathematical or technical background. Its interest obviously is to familiarize the reader with the various technical aspects of missilery, using nothing but simple language and no mathematical formulas of any kind.

Starting with an unfortunately inadequate glossary of guided-missile terms, the next two chapters are devoted to the elementary principles of missile aerodynamics and propulsion, respectively. After an elegantly simple explanation of optical and electronic principles, the bulk of the book comprises descriptive and schematic explanations of instrumentation systems.

Typical of technical manuals of today, the volume includes many large, clear, and well-drawn illustrations. In short, this book will be useful to anyone who wants to get rapidly acquainted with certain equipment fundamentals, outside of his field of competence, without requiring or drawing on an engineering education. —PHILIPPE W. NEWTON.

Air Technical Dictionary, German-English. Edited by H. L. Darcy. New York: Duell, Sloan & Pearce, Inc. (in collaboration with Walter De Gruyter & Co., Berlin). 312 pp. $10.

THE publication of this new German-English Air Technical Dictionary emphasizes the importance of Americans becoming proficient in foreign languages. The President made a particular point of this in his report on his South American trip.

This up-to-date technical dictionary will enable our engineers and scientists to interpret better the large volume of past and current German literature on air technology. Experts from the various fields of German aviation research and development have compiled those terms considered essential and relevant to each field, and have endeavored to match the German words with corresponding American expressions as accurately as possible. —E. P. MECHLING.

Turbulent Flows and Heat Transfer. Edited by C. C. Lin. Princeton: Princeton Univ. Press. 549 pp. $15.

THIS is one of twelve volumes of the series "High Speed Aerodynamics and Jet Propulsion." In keeping with the tenor of the series, this volume is a consolidation

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Book Reviews (Contd.)

of the extensive literature on turbulent flow and heat transfer that has resulted from the enormous expansion of research in the study of aerodynamics and propulsion over the past two decades.

Emphasis is naturally placed on presentation of the more advanced concepts, but the consideration given each subject is complete enough to show the logical development of present-day theory. The volume is outstanding in its comparison of experiment and theory and in defining the direction which future research should take. An extensive bibliography is provided.

The first half of the volume deals with turbulent flow while the latter half deals with transfer of heat by conduction, convection, and radiation.

A knowledge of partial differential equations is essential for full appreciation of the volume, but, even without this, the work should provide an excellent reference.—RICHARD H. SFORZINI.

Encyclopedic Dictionary of Electronics and Nuclear Engineering. By Dr. Robert I. Satbacher. New York: Prentice-Hall, Inc. 1,417 pp. $35.

WITH more than 14,000 subject entries, 17,000 cross-references, and 1,400 diagrams and illustrations, an almost unbelievable amount of data in concise and easily accessible form has been assembled in this book. The author is an outstanding authority and needs no recommendation for scholarship and accuracy to anyone conversant with the electronics and nuclear fields.

The book is undoubtedly the first attempt to include in one ready-reference volume the approved definitions, descriptions of terms, equipment, components, and systems in these important industries. While the descriptions adhere to scientific terminology, they are plain enough for the general understanding of nonscientific individuals reasonably familiar with the basic principles of electronics, and the book should be a boon not only to scientists, but to engineers and executives in these industries. The work can be described as scholarly, authoritative, comprehensive, and practical.—GEORGE S. BRADY.

BOOKS RECEIVED

Basic Ultrasonics. By Cyrus Glickstein. New York: John F. Rider Publisher, Inc. 144 pp. $3.50.

Civil Air Regulations and Flight Standards for Pilots. Twenty-second edition. By Aeronautical Staff of Aero Publishers, Inc. Los Angeles: Aero Publishers, Inc. 160 pp. $2.50.

Engineering Data Processing System Design. By Arthur D. Even. New York: D. Van Nostrand Company. 282 pp. $6.50.

Flight into Oblivion. By A. J. Hanna. Bloomington: Indiana University Press. 306 pp. $5.

Fundamentals of Stress Analysis. By Albert Deyarmond and Albert Arslan. Los Angeles: Aero Publishers, Inc. 256 pp. $5.75.

General Drafting. By Verne C. Fryklund and Frank Roy Kepler. Bloomington, Ill.: McKnight & McKnight. 204 pp. $3.40.

How To Use Grid-Dip Oscillators. By Rufus P. Turner. New York: John F. Rider Publisher, Inc. 112 pp. $2.50.

Mathematics for Engineers. Two volumes, ninth edition. By W. N. Rose. New York: John F. Rider Publisher, Inc. 527 and 403 pp. $6.60 each.

Navy Blue Book, The. Edited by Tom Compere. New York: Military Publishing Institute, Inc. 374 pp. $1.50.

Tank Commander's Guide, The. By U. S. Army Armor Human Research Unit Staff, Fort Knox, Ky. Harrisburg: Stackpole Company. 488 pp. $3.50.

Understanding Microwaves. By Victor J. Young. New York: John F. Rider Publisher, Inc. 292 pp. $3.50.

Web of Conspiracy, The. By Theodore Roscoe. Englewood Cliffs, N. J.: Prentice-Hall, Inc. 562 pp. $10.

Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Metrological Miracle

Huge Titan launching structure required watchmaker tolerances

Jeremiah F. Donovan

Chief optical tooling engineer, Greenwich Engineering Division, American Machine & Foundry Company, Greenwich, Conn.

IN former years, manufacturing problems of the metalworking industry fell more or less into either of two categories: one, the construction of large objects such as bridges or ships where the tolerance leeway was quite large; the other, the manufacture of tight-limit, precision mechanisms which, however, were ordinarily of modest dimensions and easily measured to very small tolerances.

But in the new and burgeoning art of missilery the industry has been faced with the challenging task of building structures the size of bridges to watchmaker's tolerances. The fantastic reliability requirements of our satellites and ICBM's have confronted American industry with measurement problems that would have been insoluble only a few years ago.

WE drew heavily on the modern science of optical tooling in building launching sites for the giant Titan intercontinental ballistic missile. The requirements may suggest the magnitude of the job.

It was necessary to conceal the monstrous weapon in battle readiness beneath the ground, which required an underground structure as deep as the height of a 13-story building. The housing had to be secure enough to withstand a near miss by a nuclear explosive carrying a megaton punch. It had to be earthquakeproof. Yet the entire system had to be built so accurately that the missile could be fired with precision at every target.

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Powdered Metal Bullets 952
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Savings in critical materials

Adhesives for Ordnance 954
M. J. Bodnar
New bonding method

General plan for the missile-launching system centers on a vertical concrete cylinder, or silo, the top of which is flush with ground level. A pair of massive concrete doors swings upward on hinges to permit the missile and elevator platform to rise above ground level into firing position. Within the concrete silo is a flexibly mounted steel crib which supports the elevator platform and the weapon. The elevator platform moves up and down within the crib to raise the missile into firing position and to return to cover.

CREW and auxiliary equipment are housed in remote underground shelters, all of which communicate directly, well below ground level, with the big silo containing the missile.

Before seeing how this metrological miracle was achieved, it is instructive to see what the older methods were.

When ships, buildings, or bridges were built, the job was accomplished with an ingenious array of tight piano wires, tapes, plumb bobs, and elementary surveying equipment. In most

cases, and for relatively short distances, this enabled highly skilled men to work to as close as a sixteenth of an inch. However, the relatively simple surveying transits used did not have the built-in capability to do really fine work. Many of them are reliable to only a minute of arc, when sensitivity of the order of fractions of a second of arc, more than 100 times greater, is sometimes required. Also, even under the tightest tension, due to changing and uncontrollable temperature conditions, the sag of a taut piano wire could not always be adequately allowed for.

The foremost manufacturers of surveying equipment, under the lash of necessity, applied themselves to the problem and came up with a purely optical system of measuring which has incredible accuracy and which more than satisfied even the most stringent demands of the industry.

THE basic components of, for example, the Keuffel & Esser optical tooling system were: (1) Precise leveling scope, (2) Jig transit, (3) Alignment telescope complete with all attachments, (4) Optical square (pentaprism), (5) Optical micrometers, (6) Tooling bar, (7) Calibrated tapes 200 feet or more long, (8) Optical tooling instrument stands.

Having familiarized ourselves with the basic tools, we can now discuss the phenomenon of collimation. A collimated projector of light rays sends out a bundle of parallel rays, which neither converge nor diverge (and so "meet" only at infinity). To set a projector or telescope for collimation, then, you focus it for infinity.

The telescope, looking into the lens of the projector, will then be viewing the target pattern (which may be cross hairs) located at the focal plane of the projector. When the one instrument is pointed so that its cross hairs cross the center of the target of the other instrument, the two instruments are "collimated" to each other and—this is important—are pointed in the same direction to within a fraction of a second of arc.

It is interesting to note that the two telescopes (or telescope and projector) need not be exactly on the same line of sight, but only within the diameter of the objective lens. For example, if your telescope has a 2-inch-diameter lens, the center line of a viewing telescope may be anywhere within that 2-inch circle, and the two scopes still can be mutually collimated. This wide latitude is of great practical value and convenience in the field.

A closely allied phenomenon is that of autocollimation: a single telescope set for infinite focus and looking into the image of its own illuminated cross hairs in an optically flat mirror. By such means the telescope can be squared off to the mirror to much better than one-second accuracy; and, if the mirror is mounted on the axle of a transit telescope, the two scopes can be made to sweep out mutually perpendicular sight planes. All jig transits used in optical tooling have provisions for axle-mounted mirrors.

During the construction and testing of the underground launcher for the Titan rocket it was found necessary to employ optical tooling to the fullest. Not only were occasions found to use all the standard setups and techniques with tooling bars and so on, but many unusual tricks (some no doubt unique) were devised to cope with certain situations.

For example, in order that all the underground equipment and construction be centered exactly with the opening for the huge reenforced-concrete "trapdoors" that shelter our launchers from enemy bombing attacks, we decided to project the pattern of the four corners of the door opening on the ground at the bottom of the launcher.

When you consider that the concrete silo which houses the launcher is deep enough to conceal a 13-story apartment house, and that we wanted to set benchmarks on the bottom, accurate to a few thousandths of an inch, you get some idea of the accuracy and sensitivity demanded of our "plumbing" techniques.

THIS is how we went about it. We used Keuffel & Esser's alignment scope, assembled to the K&E optical square. The telescope was equipped with the coincident striding level and the optical square with the coincident cross level—the whole assemblage being mounted in a standard cup mount and adjustable bracket.

Before using the instruments it was necessary to set the levels for a perfectly plumb line of sight. The striding level, being reversible on a precision ground barrel, is self-checking to produce a dead horizontal line of sight which is then translated to the perpendicular through the optical square. The cross level, however, lacks this feature and must be set.

To make this critical adjustment, a special fixture was made to hold two alignment scopes equipped as above, the scope on the lower level approximately at right angles to the scope on the upper level. Both scopes were adjusted until dead level was indicated by their respective striding levels. The two scopes were set for infinite focus, and their cross hairs illuminated. Then each was rotated in turn until the collimated image of the one scope as viewed through the two optical squares coincided with the cross hairs of the other viewing scope.

When the two scopes were thus collimated, the mutually perpendicular line of sight was truly plumb within the setting accuracy of the coincident bubbles of the striding levels.

NOW, while the two scopes remained immobile, the cross levels of each were adjusted to perfect coincidence. The adjustment was now complete, and in order to erect a perfectly plumb line of sight anywhere, all that was necessary was to take either of the two scopes, mount it in the cup mount and adjustable bracket, and adjust until both bubbles were coincident. The upper-level scope produced a plumb line viewing from the top down; the lower, a plumb line viewing from the bottom up. Many occasions arose to use both.

Another unusual task placed upon our metrological unit was to devise a means of telling whether a massive elevator platform, after being run up and down, would return and settle in exactly the same position every time.

In this case, "exactly" meant that we had to devise means of checking its angular repetition within one-tenth of one second of arc. This is the angle subtended by a human hair at a distance of several city blocks. Here was a job for autocollimation.

Two mirrors were rigidly mounted and attached to the elevator platform, about 90 degrees apart in orientation. Into each was pointed an alignment

scope, specially equipped with an angle-reading attachment, which enabled the two built-in optical micrometers to read seconds of arc rather than thousandths of an inch. Also, both alignment scopes were equipped with special verniers so that tenths of a second could be read out on the vernier.

Initially, both telescopes were autocollimated into their respective mirrors, and the micrometers set at zero. The physical mounting of the two scopes was now rigidly locked in place. After the elevator was run up and down, the autocollimation was rechecked and the error measured with the optical micrometers.

IT was necessary on many occasions to measure vertical distances with great precision, and this was readily accomplished as follows:

A tape 200 feet long was accurately calibrated throughout its length at the Hoboken laboratory of Keuffel & Esser, under standard conditions of tension and temperature. This tape was then permanently suspended from the top of the enormously deep concrete silo, hanging all the way to the bottom with a specially made tape weight giving the correct tension.

Leveling telescopes were then mounted as required at different levels of the giant launcher structure, and by alternately sighting the tape and sighting scales or targets affixed to the steelwork, comparative readings were taken and vertical distances easily computed with complete reliability. The leveling telescope, which contains a coincident bubble, can be leveled to better than a second of arc, so that virtually no accuracy was sacrificed in the telescope sightings; and this despite the fact that the concrete silo is greater in diameter than that of many famous underwater vehicular tunnels. (See Figure 1.)

In addition to these and other unusual setups there was, of course, continual recourse to the more "standard" optical-tooling techniques.

For example, the accompanying sketch (Figure 2) shows the arrangement by which two tooling bars were set up on the floor of the silo to measure the distance between the benchmarks projected down from the door opening far above. The way this worked is as follows:

An alignment scope (with attached

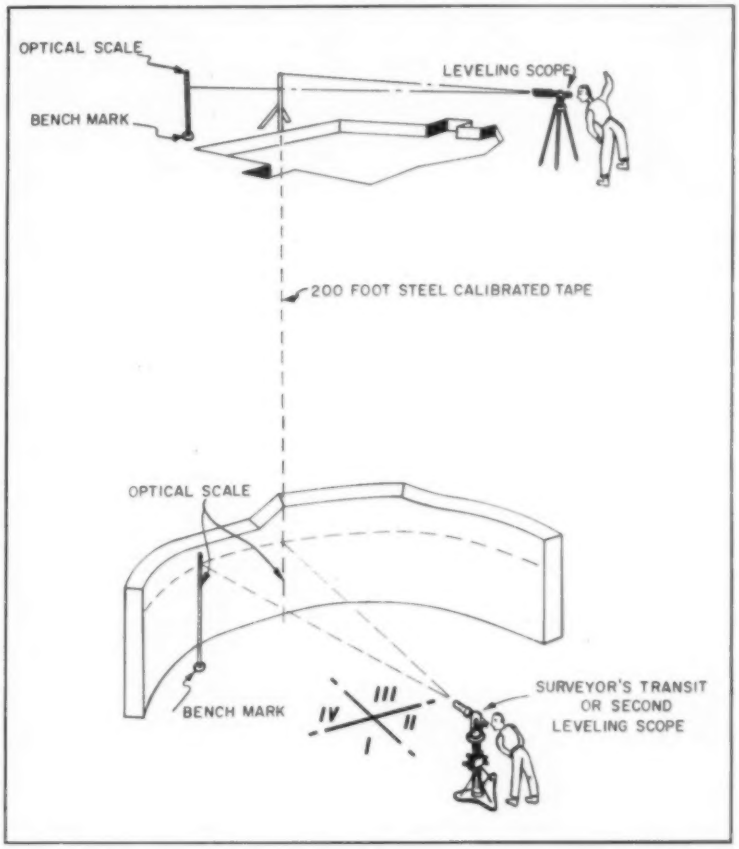
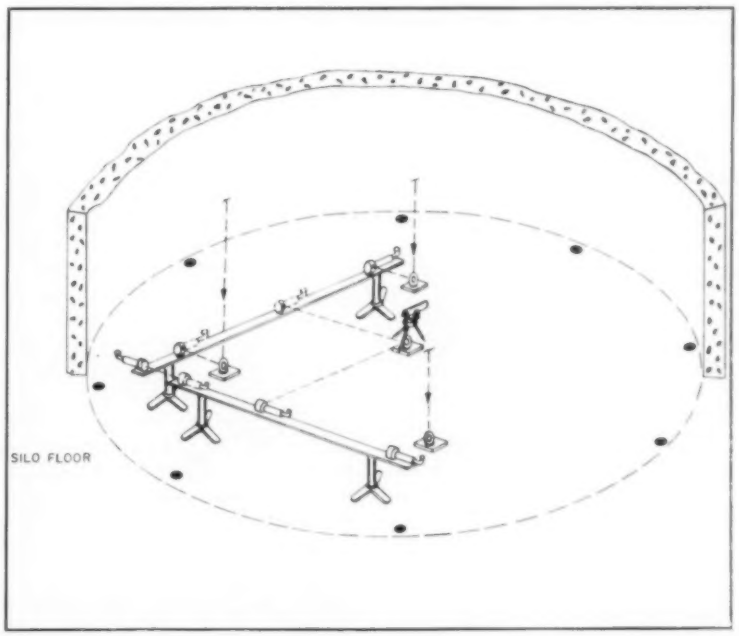


Fig. 1, above, illustrates use of leveling telescopes mounted within launcher. In Fig. 2, below, optical tooling bars measure distance between benchmarks.



optical square) was "bucked in" on two benchmarks parallel to one side of the door frame. The corner alignment scope was collimated into the first one, and held immobile thereafter, providing the two basic lines of sight 90 degrees apart along which the two tooling bars were aligned.

On each tooling bar the two sliding alignment scope assemblies were used to take readings on all benchmarks. The distances were halved and the sliding scopes positioned on the midway points.

Special projection lights incorporated into the movable alignment scopes were now flashed on, and the reticle pattern was projected onto the floor at the center of the silo. The point at which the two projected patterns intersected was dead center of the door opening far above and at this point a benchmark was permanently attached to the floor.

This now became the primary reference point of the whole operation—the "center line" of the silo, the launcher, the Titan missile—everything.

A sensitive theodolite was now mounted on a tooling instrument stand with a hollow bore and positioned directly over the benchmark. Angles were then set off with the theodolite, and, working in conjunction with alignment scopes variously positioned on the floor of the silo, numerous installations were accurately emplaced and subsequently inspected as a double check. The accompanying sketch shows such an emplacement (Figure 3).

INCIDENTALLY, we found that the easiest and most accurate way of emplacing benchmarks was simply to project the cross hairs of the instrument involved right on the wall, floor, or steelwork; it was then a simple matter to glue a plastic target in place, accurate to a few thousandths of an inch. After installation, the targets were reinspected and the deviations, if any, measured and written in right on the target itself, to be subsequently allowed for. We found 2-inch-square plastic paired-line targets ideal for this purpose.

In a typical boresighting assignment four hinged brackets must be accurately aligned over a 20-foot distance—much too long for insertion of a steel locating bar, which would sag. In any case, the space limitations were so stringent that there was no room for insertion or removal of such a bar.

An alignment scope was mounted on an instrument stand and pointed at a target in a spherical cup mount. (The cup mounts for both telescope and target had previously been located accurately by optical methods to ensure correctness of the line of sight.)

Now into each hinged bracket in turn was introduced a special facility fixture which held optical-tooling targets at either end of the hinge, on the centerline. The hinge was shimmed outward to the proper distance and slid around under the bolts, which at this stage were tightened to a light pressure only.

When visual sighting through the telescope indicated that the alignment was fully satisfactory, the bolts were taken up to full tension, and dowels were run through the brackets into the underlying steelwork. This ensured permanency of the alignment job.

ANOTHER interesting task was the erection of a number of guide rails along the wall of the silo, accurate in position to within 0.005-inch (at one end) and plumb and true over their whole length to 1/64-inch. Since the "whole length" was the height of a small skyscraper, this was quite a challenge. (See Figure 4.)

A special mounting table holding two cup mounts the proper distance apart was screwed to the top of an instrument stand and wheeled into position as determined by sightings through an alignment scope on a tooling bar, and an angle was set off from the center line by the theodolite. Fine adjustment provisions allowed final location to be varied in 0.001-inch increments.

When the table was properly positioned, alignment scopes set into pentaprism squares were placed in each cup mount and the line of sight made dead plumb upward by methods outlined earlier in this article. Special target fixtures, with glass targets mounted the same distance apart as the two cup mounts, were attached to each end of the guide-rail sections.

The sections were then "floated" into place, precisely positioned along the plumb line of sight, bolted and doweled into place. In most cases, errors of 0.001- or 0.002-inch were readily detectable, so that the limiting accuracy of the setup was not the measuring system but how well men could work in maneuvering massive steel members into position to such close limits.

Not all optical tooling setups were complicated ones, however. For example, we were asked to provide a method ensuring that the Titan missile support rests were in a dead horizontal plane, within close tolerances. This called for nothing more than placing a leveling telescope on a mount a few inches above the support points to be established.

Optical tooling scales in small, portable, vertical holding mounts were stood erect on the four support points. If the four scales gave the same reading we had our horizontal condition. Needed corrections were easily made, and a final reinspection confirmed the excellence of the work.

Complete confidence could be placed in the reliability of the survey, as the leveling telescope, involving the coincidence "split bubble" principle, can be made level to better than a second of arc.

The optical tooling scales, incorporating the "paired-line principle," can, as tests made by Princeton University bureau of standards have shown, be read with a probable pointing accuracy of 0.15-second of arc, or roughly 0.001-inch in a 100-foot distance.

THE fact that much of the work had to be done in extremely confined quarters imposed additional difficulties. In order the better to withstand the blast effects of enemy attack, the concrete housing for the rocket launcher is only very slightly larger than the steelwork of the launcher itself. One of our tasks was to set four massive locks in a steel supporting structure, roughly twenty feet square, to an accuracy of thousandths of an inch. The use of instrument stands was out of the question as there was no room. Indeed, between the top of the steelwork and the bottom of an overhanging reenforced-concrete canopy, there was not even enough room for a standard surveyor's transit.

Fortunately, however, alignment

scopes take up very little headroom, and, with the proper ancillary equipment, an alignment scope can be made to function equally as well as a jig transit. Keuffel & Esser was able to provide us with a special thin tooling bar of less than an inch cross section.

Using alignment scopes mounted on shallow carriages, we were just able to make our setup in the tiny space atop the steelwork and underneath the concrete. The tooling bar was fastened to the steelwork itself for support.

In order properly to position the locks, we made up a special target fixture which essentially was a means of accurately relating three transparent, glass crossline targets to the critical points of the lock. One target was oriented exactly over the "working point" of the lock; two other targets were spaced outboard, dead parallel to the lock shaft.

ALL three targets were mounted a standard distance above the shaft, so that they would be in line with the leveled alignment scopes on top of the crib steelwork. The whole problem was now resolved into simply that of locating the four target fixtures via visual sightings from the telescopes on the tooling bars, the squareness of the two lines of sight being held by collimating through an optical square mounted on a fixed, immobile alignment scope in one corner of the setup.

As an additional precaution against error, fixed targets were mounted beyond the ends of both tooling bars, so that if the immobile alignment scope were accidentally jostled out of position, however slightly, a check on the targets would immediately show it and allow for easy resetting to the correct pointing.

There were, of course, numerous other applications of optical tooling which were found most useful in the Titan launcher project.

American Machine & Foundry now has established a permanent optical-tooling unit with an elaborate inventory of the finest equipment obtainable and a priceless reservoir of the know-how that comes only from experience. These capabilities and know-how we share freely and fully with our associate contractors in the building of America's first line of defense—the retaliatory power of our missiles.

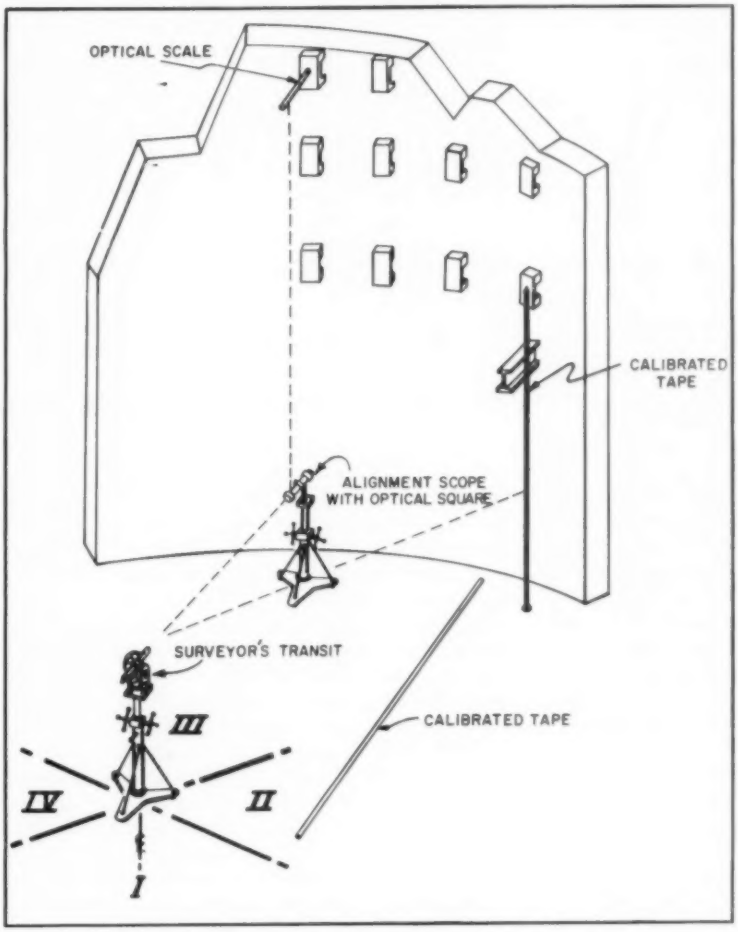
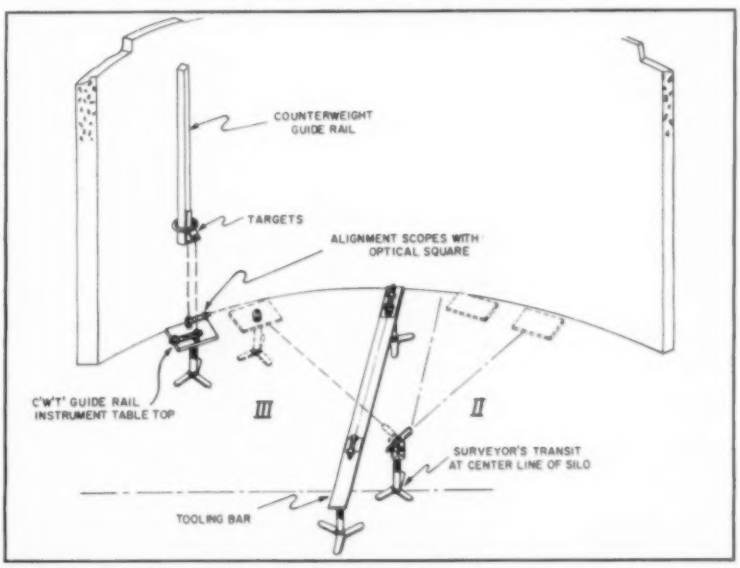


Fig. 3, above, making accurate emplacements within silo. Fig. 4, below, erecting accurate guide rails along length of silo wall.



Weapons to Fit the Man

Researchers at the Human Engineering Laboratories at Aberdeen Proving Ground realize that machines do not fight alone and are striving to design combat equipment that men can operate safely and efficiently

BLASTS of bleak arctic winds, the overwhelming heat of scorching desert air, and the droning monotony of the sound of the sea are just some of the conditions which help to wear down man's capabilities for efficient operation of equipment.

Members of research teams at the Human Engineering Laboratories at Aberdeen Proving Ground, Md., realize that machines do not fight alone —that the human operator is an integral part of current weapons systems. This branch of science therefore aims at matching machines and their tasks with the abilities of the man operating the equipment. Weapons, the investigators feel, must combine the design of the machine with man's faculties.

In order to keep down expenses and for the most practical study purposes, many tests are simulations of the actual field situation. For example, in the electronics laboratory, data on the Cobra missile are fed into an analog computer which digests this information and passes it along to an oscilloscope which is then used to study the ability of operators to guide the missile in on a simulated target.

THE operator of the equipment, in this case, is one man who sits in a swivel chair with his hand on a simulated "joy stick" as the control. He is tracking a missile on the radar screen, and his every reaction is being recorded. Although the operator is not under the stress that he normally would be under in an actual field situation, a close approximation of his accuracy can be estimated.

In another study, physiological changes such as galvanic skin resistance can be measured, and excitability and attention span can be studied.

A CORRELATION between the man's alertness and his physiological factors can be drawn. How effectively is the man doing his job? The researcher can come pretty close to answering this question with a great degree of accuracy by gathering and evaluating the data at the end of each "run."

Technical advice on the application of these findings is then given to the appropriate design agencies, and an appraisal of the existing matériel is made. If sound human engineering practices were not adhered to in the design, recommendations for modification of the equipment or weapon are made.

The concept of a vehicle driver in an upright position is ages old. However, at Aberdeen's Human Engineering Laboratories another idea was tried out —that of the evaluation of a driver's ability to operate a tracked vehicle from a fully prone position. Twenty-four subjects, military and civilian, who had varied amounts of experience in driving, were tested in the M41 tank on cross-country road courses and precision test courses.

The six drivers who were judged to be the best on these courses were further tested on a demanding hill course where they were required to drive for a period of four hours, taking rest stops whenever they wished or until they decided to end the test.

Results showed that the prone position is no barrier to efficient operation of the vehicle. However, as a result of these studies, complaints from subjects were voiced as to vision, vibration transmitted to the head, accelerator responsiveness, and steering and brake controls. Some of these complaints had been anticipated, but, considering the limited design modifications permitted to the vehicle, the result was a good compromise.

Researchers determined that the M41 medium tank could be operated adequately over widely different types of terrain from the prone position; that subjects in the prone position were capable of operating the test vehicle for considerable periods of time over demanding terrain; and that a number of the subjects' complaints were due to the limited design changes permissible.

FIELD liaison teams have played an important role in discovering the "bugs" in some of the equipment already in operation. For example, a preliminary field investigation and two surveys among tank crewmen of the 90-mm.-gun tank M48 at Fort Hood, Tex., and at Camp Irwin, Calif., were made to find out from the users what significant human engineering problems were being encountered.

The group-interview technique was used in these studies because of the economy of time and manpower. It also was felt that the group technique is advantageous because many problem areas may be revealed by stimulation from one of the subjects of the group which would not be brought out in an

individual interview. One disadvantage, however, the investigators found, was that of bias. One member of the group, in stating his opinion, might influence the opinions of others in the group.

QUESTIONS such as the following were asked of all users of the tanks: Have you ever had any headaches or dizziness due to the noise level? Does the ventilating blower adequately rid the tank of gas and fumes when the tank is firing with the hatches open? Does the heater give you sufficient warm air? A record was made of the frequency of each "yes" and "no" answer so that an evaluation could be made of the problem areas to be encountered when using the equipment.

In another study, the relationships of intermittent noise, intersignal interval, and skin conductance to vigilance behavior were explored. Three levels of intersignal variability and a quiet and intermittent-noise condition were compared for effect on monitoring performance. Basal skin resistance was continuously recorded during the watch to determine its utility as an index of vigilance.

These studies showed the adverse effect of high-intensity noise on monitoring tasks which require scanning, the sensitivity of monitoring to changes in sound intensity, and the effect of noise in causing momentary lapses of attentiveness.

Other areas of research already have been covered. Techniques often utilize previously known principles but in a different combination or application.

At the present time, new electronics methods of displaying information to radar operators, and ways to instrument, measure, and analyze impulse-type noise associated with firing of shoulder weapons are being evaluated. Also being considered are ways to telemeter physiological and psychological data from a mobile field test situation to a central recording station without having the test personnel aware of the monitoring.

OPERATING on a low budget of about $1 million this year, the Human Engineering Laboratories at Aberdeen has a team of only 62 civilian and 35 military personnel. Of these personnel, 50 are professional men. The team is a heterogeneous group consisting of those trained in experimental and industrial psychology, engineering, physics, electronics, biology, physiology, industrial design, and industrial engineering.

Staff members are proud of their record, for the agency, established only nine years ago, has extended a helping hand to eight Army Ordnance establishments, as well as to many industries across the Nation engaged in defense projects.

Animals, too, are giving their support to the project by participating in sound studies, isolation tests, and in providing other types of psychological data so important to making man and machine into a real team. Most of these animals are Rhesus monkeys, housed in modern, sanitary quarters.

The laboratory is equipped with a small experimental shop which can fabricate all the material and facilities necessary to support human-engineering activities. Other facilities on the premises include a comprehensive library of professional journals, technical reports, and business and engineering magazines. There are also still and motion-picture cameras, recording machines, conference rooms, and provisions for illustrating and drafting.

Research is conducted on human psychomotor performance, control arrangements, information handling, displays, systems components, anthropometric measures, orientation in space safety, and unusual environments.

The Human Engineering Laboratories, which has three main laboratories under the office of the director, is a close-knit organization. The three main laboratories—Supporting Research, Systems Research, and Engineering Research—work across the board when a study is undertaken.

GENERALLY speaking, the first deals with the human elements with its Sensory Branch, Psychomotor Branch, and Environmental Branch while the Systems Research Laboratory adds its knowledge via the Vehicle Branch, the Short-Range Direct Fire Weapons Branch, the Long-Range Indirect Fire Weapons Branch, the Surface-to-Air Weapons Branch, and the Concept Development Branch. The third laboratory, Engineering Research, includes the Design and Fabrication Branch and the Application and Special Projects Branch to round out a well-balanced working group.

Dedicated workers here feel that man is the ultimate weapon. Thus it is the goal of the U. S. Army Ordnance Human Engineering Laboratories to provide man with the ultimate matériel designed specifically to accomplish his needs and compatible with his abilities, so that he may most efficiently and economically defend himself and his country.

Experiments in operating a modified M41 tank from a prone position could make possible a much lower silhouette in future tracked-vehicle designs.

Powdered Metal Bullets

Experiments being conducted at Frankford Arsenal show that, with minor modifications, the 7.62-mm. NATO ball bullet can be made from iron powder with consequent savings in critical materials

Robert A. Powell

Mr. Powell is with the Pitman-Dunn Laboratories, Frankford Arsenal, Philadelphia, Pa. This article was presented as a paper before a recent meeting of the A.O.A. Powder Metallurgy Section at Picatinny Arsenal, Dover, N. J.

FRANKFORD Arsenal is currently conducting a program dealing with the fabrication of 7.62-mm. ball bullets by powder-metallurgy techniques. The purpose of this program is twofold: first, of course, is to achieve economy and, secondly, possible conservation of copper and lead. During the last war, both copper and lead became critical materials and their uses were limited. It appears that if a national emergency should arise, these materials would again become scarce. A bullet which conserves these materials would have great military value. It must be remembered, however, that the materials must not be conserved at the expense of ballistic properties.

The standard NATO 7.62-mm. ball bullets are the M59 and M80. The M59 bullet is referred to as the 4-piece bullet and has four basic segments: (1) gilding-metal jacket, (2) lead filler (point), (3) lead filler (base), (4) steel core.

The weight requirement on this bullet is 150.5 — 5.5 grains. Based on a volume of 1.11 cc., the density requirement is from 8.41 to 8.79 gm./cc. The composition of the bullet by weight is as follows: 37.9 per cent gilding metal, 36.5 per cent lead, and 25.6 per cent steel.

THE M80 bullet (Fig. 1) is being manufactured for and used by the military. It can be produced more economically than the M59 because of the simpler design. This bullet is referred to as the 2-piece bullet and has two basic segments: (1) gilding-metal-cladded steel jacket and (2) lead filler.

The weight requirement of this bullet is 149.5 — 3.0 grains which is similar to that of the M59 bullet. To accomplish similar weights it was necessary to decrease the length to 1.14 inches. The density of this bullet based on a volume of 0.94-cc. would be from 10.11 to 10.31 gm./cc. The composition of this bullet by weight is as follows: 7 per cent gilding metal, 77.6 per cent lead, and 15.4 per cent steel.

The amount of lead used in this bullet could be decreased by increasing the thickness of the steel jacket. This thickness, however, would have to be increased considerably to get any appreciable decrease in the amount of lead. A thicker jacket would also be much more difficult to fabricate and possibly would increase bullet engraving pressures.

Powder metallurgy was thought of as a means of mass producing these bullets economically and still conserving critical materials.

Of the materials considered for the fabrication of the powder-metallurgy bullet, iron powder was the obvious choice, since it is quite abundant and relatively cheap. This was considered essential to this evaluation even though iron, with a theoretical density of 7.87 gm./cc., could not meet the weight requirement. The bullet density could be increased by either admixing a higher-density material with the iron powder or infiltrating it into the compact. Both of these processes are commonly used in the powder-metallurgy industry.

THERE are many materials that can be used as admixers with the iron powder. However, the number of materials which can be infiltrated is limited. This is because of the additional physical requirement that this high-density material have a melting temperature lower than that of iron. The choice of materials for increasing the weight is further limited in that they would have to be ductile and relatively low in cost.

Copper and lead are two materials which meet these requirements, and they offer additional advantages—copper, as an admixture or infiltrant, will increase the strength of the bullet, and lead will improve its antifriction properties.

The first design of a bullet suitable for molding by powder-metallurgy techniques has the same basic dimensions and tolerances as the standard M59, except for the boattail and can-

nelure. The boattail could have been molded, but was not considered essential for the preliminary evaluations. The cannelure would, however, have to be machined.

The tool set used in making these bullets consisted of an upper punch, a cylindrical die, and a flat-faced lower punch for molding the ogive, body, and base of the bullet, respectively. A plunger was provided in the upper punch to ensure positive ejection of the ogival portion of the bullet.

The tooling was assembled in a floating die table and used with a single-ram hydraulic press. With the lower punch and die adjusted, the die cavity was filled with powder. The upper punch pushes against the die, which was supported by a spring. As the upper punch and die were moved downward, the powder was compacted against the stationary lower punch. As a result, the ogive was formed in the cavity of the punch and the base end was formed in the die. The load applied was about four tons.

As the pressure was reduced, the spring-loaded die followed the upper punch. When the upper punch and die were about to separate, air pressure was applied to the ejection plunger which pushes the ogive portion of the bullet free from the upper punch. The body portion remained in the die. The die table was then pushed down and the bullet body was stripped from the die by the stationary lower punch.

As the fabrication experiments were conducted, it was found that air pressure was not suitable for movement of the plunger for ejection as it produced an impact type of movement which resulted in the identation of the bullet tips. The existing tooling, with slow, manual ejection was used to fabricate the various lots of bullets, since the scope did not include the design of production tools.

IT was necessary to rearrange the tooling to accomplish the manual ejection of the ogive section of the bullet. Although the tooling was inverted, the relative movements for compaction were identical. The powder fill, however, was adjusted by weight rather than volume. In the ejection cycle it was first necessary to eject the bullet from the die prior to the manual ejection of the ogive section.

The conclusions of the report are as follows:

1. A 7.62-mm. bullet, with minor design modifications, can be fabricated by powder-metallurgy techniques.

2. Iron powder is a suitable base material for fabricating the bullet, although this material alone cannot meet the density requirement. The density of the compacts can be increased either by admixing a higher-density material with the iron powder or infiltrating it into the compact.

3. The bullets fabricated from iron and copper (either as an admixture or infiltrant) had ample strength to withstand the stresses encountered in the firing tests. The bullet body surface showed characteristic engraving.

4. The bullets fabricated from iron and infiltrated with a lead-bismuth alloy remained intact in the firing tests. The bullet surface, however, was not engraved. Instead, the bullet diameter was decreased and some densification of the bullet occurred.

5. The bullets fabricated from iron powder showed characteristic engraving after firing, but were not strong enough to remain intact.

6. Firing pressures and velocities were normal, but the accuracy varied from very good for most of the rounds to very poor for the infiltrated bullets.

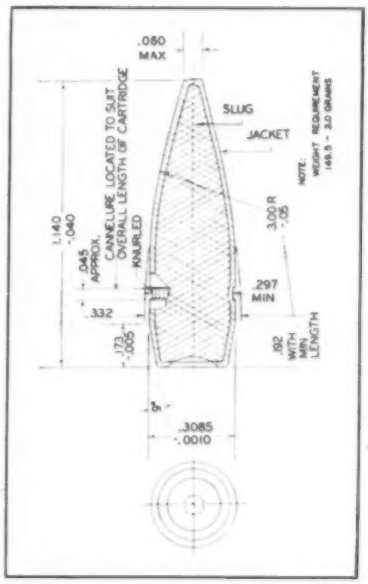
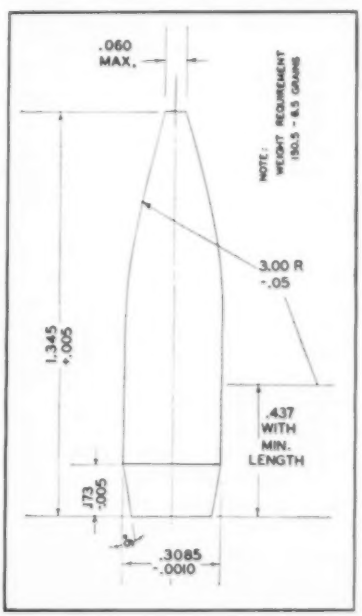


Fig. 1, above, NATO bullet now being manufactured. Fig. 2, below, bullet proposed to be made by powder metallurgy.



THE weight requirement could not be met using this bullet design. The poor accuracies of the infiltrated bullets were attributed to nonuniform distribution of the infiltrant.

The problem of meeting the weight requirement was resolved by designing a bullet (Fig. 2) with a length slightly longer than the M59 and equivalent to that of the M62 tracer.

The boattail was included in this design since it does affect the accuracy of the bullet. To utilize the existing tooling, the boattail had to be machined.

Bullets were molded from an iron powder, as previously described, to meet the longer length. They were then sintered at 2,050 degrees Fahrenheit in a dissociated ammonia atmosphere, and finally infiltrated with copper. It was found necessary to size the bullet to regain concentricity. The boattail and cannelure were then machined.

These bullets were tested for pressure, velocity, accuracy, and penetration. The results were good. In the next phase of the program the bullets must be tested for gun-barrel erosion.

A lot of about 25,000 pieces will be required for this erosion test. A lot of this size is, of course, much too large for the laboratory setup, and it therefore will be necessary to seek the aid of industry in producing these test bullets.

Adhesives for Ordnance

For many high-strength weapons applications the new adhesives are superior to mechanical means of attachment and can be employed very successfully if proper design and adequate process control are used

M. J. Bodnar

ADHESIVES are being used successfully today in many ordnance applications where high-strength performance characteristics are required. Numerous missiles, including the Army's Hawk, Lacrosse, and Nike, and the Air Force's Bomarc have vital components held together structurally by adhesives. In most such applications, the adhesives are used independently of metallic fasteners or other means of mechanical attachment.

Adhesives offer a number of advantages over mechanical means of attachment as they: (1) Allow relatively uniform distribution of stresses over the entire bonded area; (2) present aerodynamically smooth surfaces; (3) give a high strength-to-weight ratio; (4) can be used to join components with complex geometrical configurations; (5) can join thin sheets; (6) can provide effective seals against moisture, fuels, chemicals, and gases; (7) dampen vibrations; and (8) increase electrical resistivity.

SEVERAL important types of adhesives used to obtain high-strength bonds are the epoxies, epoxy-phenolics, nitrile-phenolics, and vinyl-phenolics.

Some specifications under which these structural adhesives may be procured are MIL-A-5090B, "Adhesive, Airframe Structural, Metal to Metal"; MIL-A-8431, "Adhesives, Heat Resistant, Airframe Structural, Metal to Metal"; MIL-A-8623A, "Adhesive, Epoxy Resin, Metal to Metal Structural Bonding"; and MIL-A-14042, "Adhesive, Epoxy."

Mr. Bodnar is chief of the Adhesives Research Unit, Picatinny Arsenal, Dover, N. J.

The best approach to achieving good performance in bonded joints is to select the proper adhesive, design the joint properly for the specific application, and maintain rigid process control. Selection of the proper adhesive for each application is an important consideration. The adhesive chosen must provide a bond that will withstand the types and magnitudes of stresses experienced in the end-item application during conditions of both storage and use.

The bonded joint must perform satisfactorily under the various environmental conditions that it will encounter, so it is obvious that the best adhesive available will do a good job only if properly used. Yet it can be stated that more than ninety per cent of the premature failures in adhesive-bonded assemblies are due either to improper use of the adhesive or poor design of the bonded joint.

Close process control can ensure proper use of the adhesive. Education of the design engineer to design specifically for adhesives when he intends to use them will result in stronger bonded assemblies. It has been found that many engineers design for mechanical fasteners and then, for various reasons, switch to adhesives. The result is often unsatisfactory.

One disadvantage in the use of adhesives is the absence of good nondestructive tests to determine the strengths of adhesive-bonded joints in a wide variety of ordnance applications. A weakly bonded joint may look just like a high-strength joint. A weak joint may sometimes fail under a light load, far below expectations of the designer. This is one of the chief problems facing the ordnance design engineer when he contemplates using adhesives for structural applications.

ARMY Ordnance has sponsored work under contract on the nondestructive testing of adhesive-bonded joints. While no practicable test method has yet been developed, important scientific phenomena related to adhesives and plastics have been uncovered during the investigations. Other Government agencies and private industry also are sponsoring work leading to the development of practicable nondestructive tests.

There are, however, several methods which may be used to determine the effectiveness of bonded assemblies for most designs. Perhaps the most important of these is rigid process control. Close surveillance by trained personnel is maintained at all critical phases of the bonding process. This includes the cleaning procedure, selection and application of the adhesive, and cure of the bonded joint.

Test panels are sometimes sent through the production operation with the standard assemblies being bonded. These test panels are treated exactly the same as the standard assemblies, then they are tested to destruction to determine the actual bond strengths obtained with the particular process.

Although other test methods are available, process control is highly effective for most Ordnance applications. Military Specification MIL-A-9067B, "Adhesive Bonded Metal—Process and Inspection Requirements," provides a good guideline for setting up a satisfactory process control.

One section of the Army Ordnance pamphlet on adhesives, ORD-P-20-306, is devoted entirely to the design of adhesive-bonded joints for specific materials. For maximum effectiveness, joints should be designed to minimize stress on the adhesive by stressing it in the direction of its maximum strength. For instance, many structural adhesives offer excellent resistance to shear and tensile stresses but must be protected from peeling or cleavage stresses.

THE pamphlet shows various methods by which adhesive joints can be designed to avoid these peeling stresses. Copies of this pamphlet are available to Government agencies from the Commanding Officer, Rock Island Arsenal, Rock Island, Ill. (Attention: ORDBC-5112).

Other books that may be useful in designing for adhesive-bonded joints include the Naval Ordnance Adhesives Handbook and a recent publication of the McGraw-Hill Book Company, "Adhesive Bonding of Reinforced Plastics."

At Picatinny Arsenal, which has the Army Ordnance mission responsibility for adhesives, considerable emphasis has been placed on the study of epoxies. The epoxies are among the best high-strength adhesives available. They are solventless and will bond effectively to a wide variety of materials with little or no pressure.

Epoxies can be cured at room temperature by using aliphatic amines as curing agents. When superior bond strengths are required for use at elevated temperatures, aromatic diamines or acid anhydrides can be used as curing agents. With these agents, however, an elevated-temperature cure of 110 degrees centigrade or higher is required.

Although epoxies possess many desirable characteristics that make them ideally suited for many ordnance applications, they have rather poor resistance to impact loads. The impact strength of epoxy resins can be improved by modifying them with flexible polymers such as polyamides or polysulfides or by adding fillers. Many commercial epoxy resins are modified in this manner.

NUMEROUS commercially available epoxies have been evaluated at Picatinny Arsenal for tensile and impact bond strengths at temperatures ranging from minus 65 to plus 160 degrees Fahrenheit. The results of these tests, including the relative viscosities and pot lives of the adhesives, are being published.

A study also has been conducted on the correlation of the polymer structure of the epoxies with their shear and impact bond strength behavior. Basically, the bisphenol portion of the epoxy molecule was altered in order to determine the effect of various substituents on the mechanical properties of the resin. The results of this study will be published shortly.

Among the most important uses of adhesives is the bonding of metals. At Picatinny Arsenal we have determined bond strengths obtainable to such common metals as steel, aluminum, copper, cadmium, and zinc, as well as to a wide variety of unusual metals which may be used for special purposes, especially in atomic or missile applications. These metals include beryllium, niobium (columbium), gold, molybdenum, rhenium, tantulum, tungsten, uranium 238, and zirconium.

A special technique was developed for bonding uranium 238, which is normally difficult to bond because it oxidizes rapidly to form a mechanically weak oxide layer. Tensile adhesion bonds of 1,000 to 2,200 p.s.i. have been obtained to this metal with the new method. The bond strengths of test specimens remained essentially the same after storage for one year.

Numerous data also have been obtained on the adhesive bonding of high explosives to themselves and to other adherends. The explosives investigated included Cyclotol 75/25, RDX-polystyrene, and HMX-cellulose nitrate compositions. Whether the bonded explosive assembly was tested statically or dynamically, failure always occurred in the explosive, never in the adhesive.

The tests demonstrated that the explosives, including plastic-bonded ones, are mechanically weak. Their low mechanical strength is further decreased by elevated temperatures, storage at elevated temperatures, brittleness induced by low temperatures stress concentrations induced at low temperatures by differential thermal coefficients of expansion, and the deleterious effects of some adhesives. If proper adhesives and bonding procedures are used, failure should occur in the explosive.

In the assembly of one safety and arming device, epoxy adhesives are used to bond a number of components. A silicone is used for potting one electrical component. Then all the electrical components are encapsulated with an epoxy resin and the box is sealed tight with a polysulfide. The entire box is then coated with a tough, impact-resistant coating of polyurethane.

IN fulfilling its mission responsibility for adhesives, it is important that Picatinny Arsenal provide the type of information which will be most helpful to the ordnance design engineer. Where no data are available, tests are designed for specific end-item applications to take into account the magnitude, type, and duration of stress; environmental conditions; geometry of the bonded joint; and types of adherends.

"The best approach to achieving good performance in bonded joints is to select the proper adhesive, design the joint properly for the specific application, and maintain rigid process control.

"Selection of the proper adhesive for each application is an important consideration. The adhesive chosen must provide a bond that will withstand the types and magnitudes of stresses experienced in the end-item application during conditions of both storage and use."

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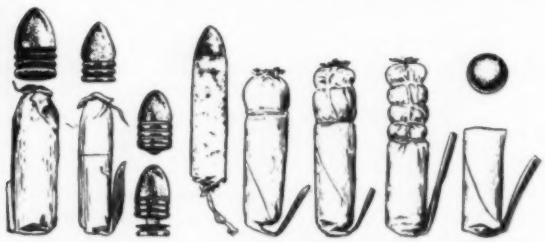

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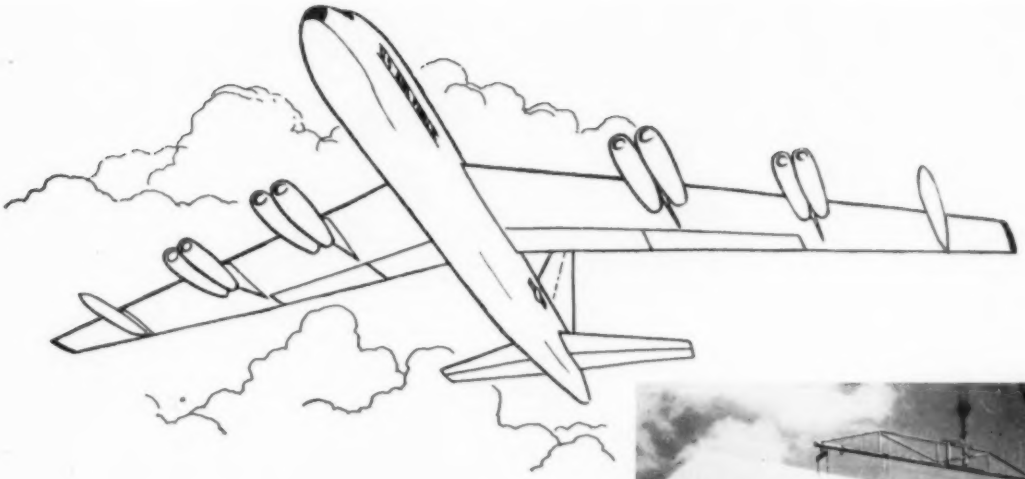

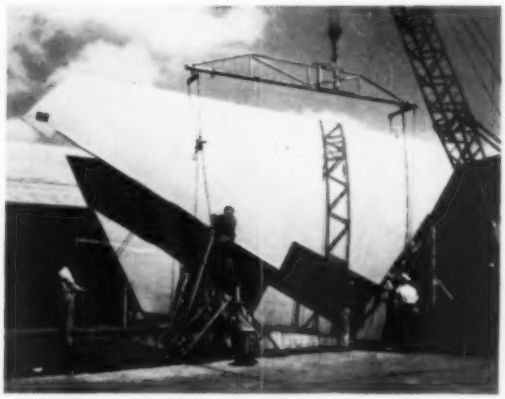

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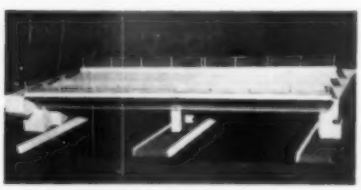

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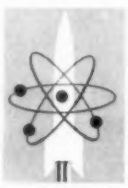

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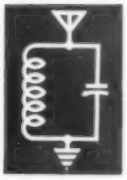

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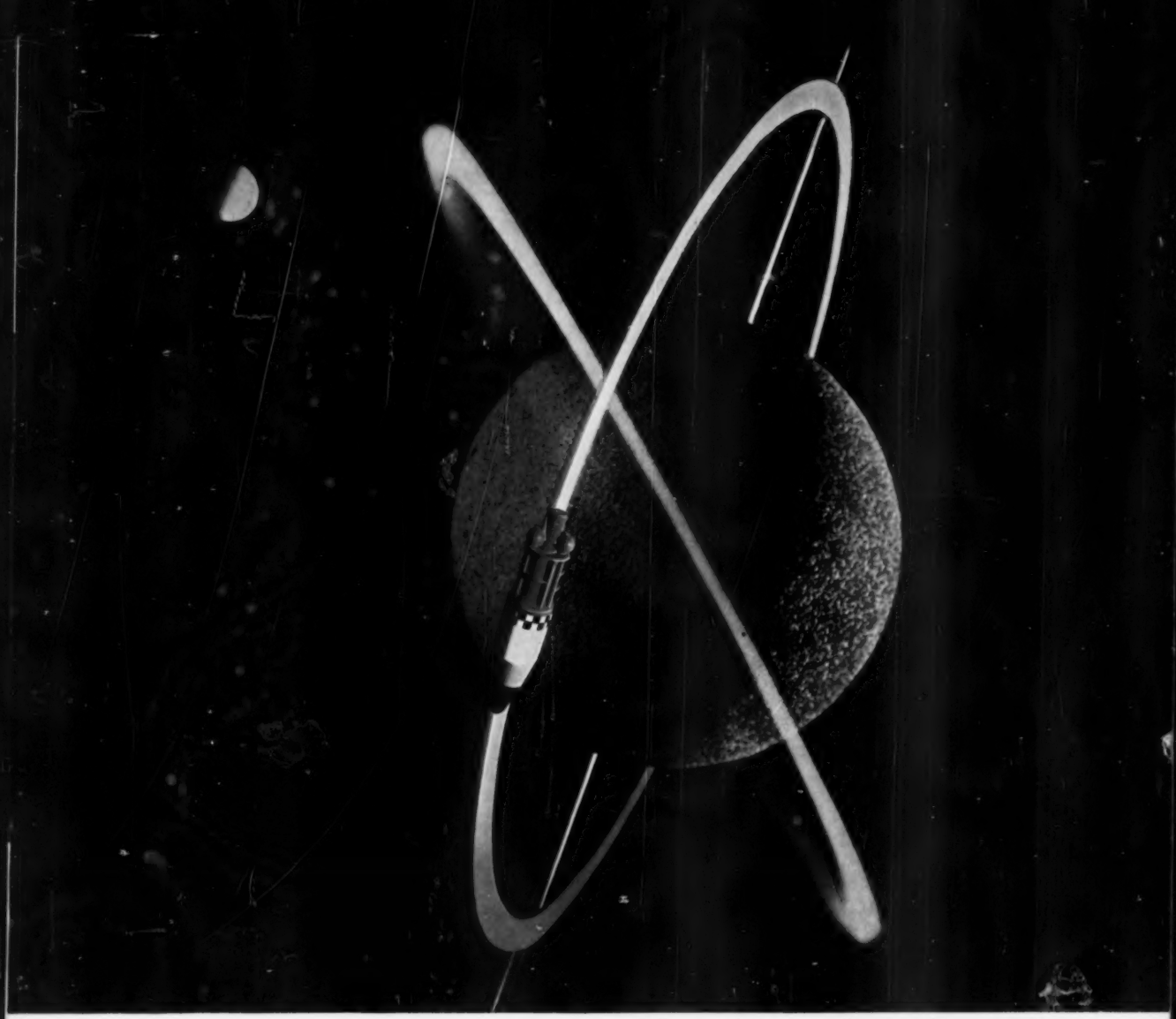

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